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R.L. Debicki

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Foreword

The metavolcanic-metasedimentary sequences of the Huronian Supergroup represent fluviatile, marine and glacial paleoenvironments and have been studied by many researchers since very early in the history of Canadian geology. The early interest focussed on regional mapping and paleoenvironmental interpretations. The supergroup is also important from an economic point of view. It contains the uranium deposits of Elliot Lake. Minor gold is known to be associated with some clastic metasedimentary units of the supergroup.

The present report is the result of a paleoenvironmental study designed to improve our understanding of the mineral potential of the rocks of the Huronian Supergroup in the Cobalt Embayment northeast of Sudbury.

V.G. Milne
Director
Ontario Geological Survey

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm²	0.155 0	square inches	1 square inch	**6.451 6**	cm²
1 m²	10.763 9	square feet	1 square foot	**0.092 903 04**	m²
1 km²	0.386 10	square miles	1 square mile	2.589 988	km²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm³	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm³
1 m³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m³
1 m³	1.308 0	cubic yards	1 cubic yard	0.764 555	m³
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

Stratigraphy, Paleoenvironment and Economic Potential of the Huronian Supergroup in the Southern Cobalt Embayment

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R.L. Debicki

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Abstract

The study area covers parts of ten townships in the area immediately northeast of Sudbury. The area is underlain by Early Proterozoic rocks of the Huronian Supergroup, which rest unconformably on Archean granitic and mafic metavolcanic basement rocks. The Huronian Supergroup has been intruded by Nipissing gabbro bodies, the Sudbury Igneous Complex and olivine diabase dikes.

Stratigraphic mapping of the Huronian Supergroup was carried out. The distribution of the formations was examined, and sedimentary depositional features interpreted. Petrographic studies of the main rock types present in each formation were done. Investigations into the potential for paleoplacer gold deposits within the Huronian Supergroup were also carried out.

A model involving deposition at the northern margin of an elongate basin at a rifted continental margin is proposed for the lower half of the Huronian Supergroup. The upper half of the succession was deposited in a more open continental margin environment, after the initial rift was filled by the deposits of the lower part of the succession. Deposition involved cyclic sedimentation of glacial-marine and glacial deposits, shallow to deep marine pelitic deposits, and fluvial to marine tidal shelf arenite deposits. The potential for paleoplacer gold deposits in these deposits is low, except for within braided fluvial deposits at the base of the succession in the northern part of the area. These deposits are poorly exposed and of limited extent; exploration of them will be difficult.

Résumé

La région étudiée couvre une partie de dix cantons dans la région directement au nord-est de Sudbury. Le substratum rocheux de la région est formé de roches du Protérozoïque inférieur faisant partie du Supergroupe Huronien, reposant de façon discordante sur les roches granitiques et métavolcaniques mafiques du socle Archéen. Le Supergroupe Huronien a été pénétré par les massifs de gabbro du Nipissing, le Complexe igné de Sudbury, et par des dykes de diabase à olivine.

La cartographie stratigraphique du Supergroupe Huronien a été réalisée. La distribution des formations a été examinée, et les caractéristiques des dépôts sédimentaires ont été interprétées. Des études pétrographiques sur les principaux types de roches présents dans chaque formation ont été faites. Des études sur la présence possible de paléoplacers aurifères dans le Supergroupe Huronien ont aussi été conduites.

Un modèle impliquant une accumulation sédimentaire le long de la marge nord d'un bassin, de forme étirée, situé sur un fossé central est suggéré pour la moitié inférieure du Supergroupe Huronien. La moitié supérieure de la série s'est formée dans une marge continentale plus ouverte suite au remplissage du fossé central par les sédiments de la partie inférieure de la série. Les couches sédimentaires ont été formées par une sédimentation cyclique de dépôts glaciaires et glacio-marins, de dépôts argileux marins profonds et peu profonds, et de dépôts d'arénites fluviaux et de littoral marin. Le potentiel pour des paléoplacers aurifères est faible sauf pour ce qui est des dépôts de rivières anastomosées en tresse, à la base de la série dans la partie nord de la région. Les affleurements de ces dépôts sont peu fréquents et d'étendue limitée; ce que n'en facilite pas l'exploration minière.

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Introduction

The study area lies in the southern Cobalt Embayment and is located immediately northeast of the City of Sudbury. It includes parts of McKim, Neelon, Dryden, Garson, Falconbridge, Street, Maclennan, Scadding, Davis and Rathbun townships. Access is provided by Highways 69 and 17, as well as municipal and regional roads. Additional access is provided by cottage roads, company roads on Falconbridge Limited property and abandoned exploration and logging trails.

This project was undertaken to obtain a better understanding of the stratigraphy and paleoenvironment of the Huronian Supergroup in the southern Cobalt Embayment, and to determine whether paleoenvironments that might host paleoplacer gold mineralization are present (Mossman and Harron 1983). The area of investigation is shown in Figure 1.

Acknowledgments

The author was aided in this work by a number of people. Able field assistance was provided by Yves Clément during 1986. Most of the drafting was done by Clive Stephenson during the time he was employed as a geological assistant during the winter of 1986-87.

During the course of field work, Falconbridge Limited provided access onto company property, and allowed use of private company roads. Facilities for carrying out petrographic analyses were provided by the Department of Geology, Laurentian University, Sudbury. All possible assistance was provided by the staff of the Sudbury Resident Geologist's office, Ontario Ministry of Northern Development and Mines, for which the author is grateful. Discussions with Burkhard Dressler, Precambrian Geology Section, Ontario Geological Survey, and Wilf Meyer, Sudbury Resident Geologist, also proved helpful.

Stratigraphic Mapping

Existing geological maps and reports were used to select traverse lines giving the best possible exposure across individual formations. Areas where repetition of a section occurs due to previously known folding and faulting (Dressler 1984a, 1986) were avoided, as were areas where a section was disrupted by Nipissing gabbro intrusions. Areas where well-developed Sudbury Breccia bodies were reported were also avoided, although breccia was found along some traverse lines. Where large breccia bodies were encountered, measurement of the stratigraphic section was terminated. Faulting, Nipissing gabbro intrusions, Pleistocene glaciofluvial outwash deposits, and industrial and residential developments disrupted and obscured parts of the succession through much of the southern Cobalt Embayment area, so that uninterrupted sections across entire formations were present in only a few places. The locations of the traverse lines are indicated on Figure 2. They are also shown, along with the traverse numbers, on Figure 3 (*see* back pocket).

Features including bed thickness, rock colour and composition, grain size and shape, and postdepositional deformation were measured and recorded. Structures including parallel and cross-bedding, ripple cross-lami-

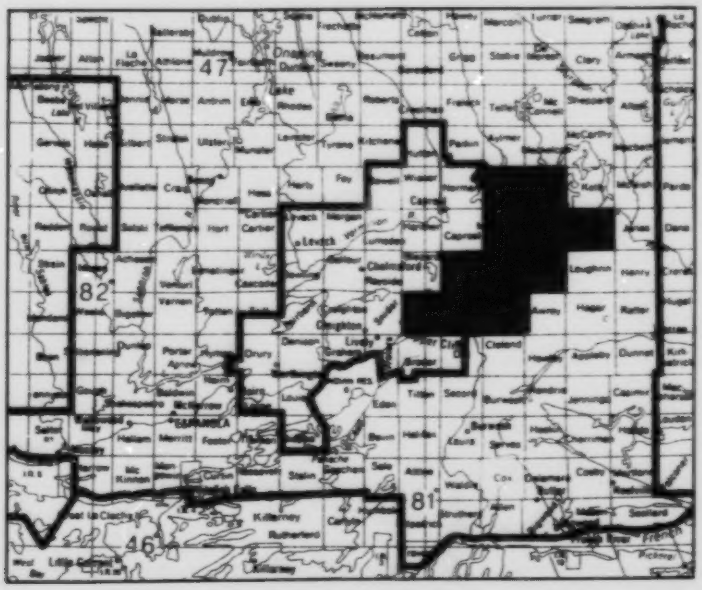


Figure 1. Key map showing location of the southern Cobalt Embayment. Scale 1:1 584 000.

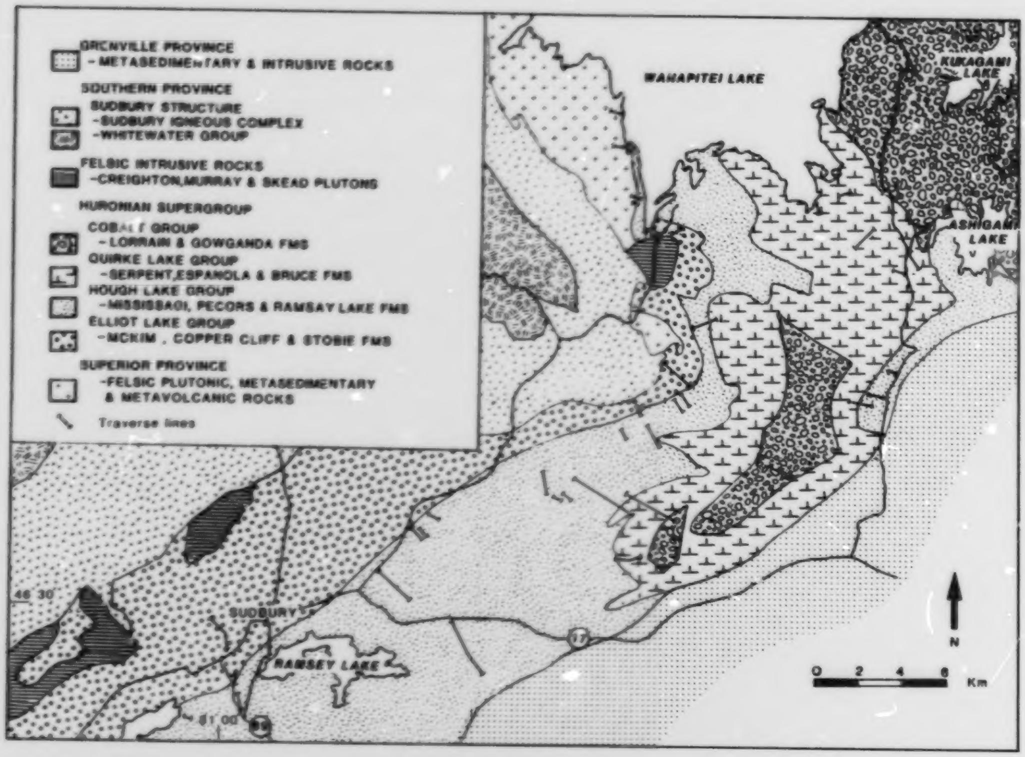


Figure 2. Simplified geological map of the southern Cobalt Embayment.

nations, flute marks, pebble abundance, rock type and orientation were also measured and recorded. Stereographic projections were used to determine the direction of flow during deposition of units bearing current-generated features.

Diagrammatic stratigraphic columns for most of the traverse lines are included in Appendix 1. A few sections were not plotted because of structural complexity encountered while measuring the section, or because the traverse was done to check a specific site rather than to measure a section. The numbers of the sections which cross each formation, and the part of each formation crossed, are listed in the introduction to Appendix 1. An explanation of the chart used to plot the stratigraphic columns is also in this introduction. The stratigraphic columns indicate general rock type, grain size, bed thickness and most depositional features. Other significant characteristics are described in comments on the chart.

Petrographic and Geochemical Analyses

Modal analyses were done on 85 thin sections prepared from samples belonging to the Huronian Supergroup. Rock names were assigned using the classification of Young (1967) shown in Figure 4. Phyllosilicates of obvious detrital origin are included with lithic fragments in this classification. In addition, two samples of Nipissing intrusive rocks were modally analyzed. The locations of the samples are indicated on Figure 5 (*see* back pocket). The samples which have undergone modal analysis are listed in Tables 1, 2, 4, 6, 8 and 10 of Appendix 2, where they are subdivided according to formation and listed numerically. Also included in the tables are the modal analyses, the final map legend number and the field name of each rock.

Samples which have undergone whole rock geochemical analysis and trace element geochemical analysis are also indicated on Figure 5. Whole rock geochemical analysis was done on 26 samples from the Huronian Supergroup, one sample of Nipissing intrusive rock, and one sample of quartz-carbonate vein material. Tables 3, 5, 7, 9, 11 and 12 of Appendix 2 list the results of the whole rock geochemical analysis. The samples are subdivided according to formation. Trace element geochemical analysis was done on 63 samples from the Huronian Supergroup, two samples of Nipissing gabbro, two samples of Archean basement rock, seven samples of quartz vein stockworks, eight samples of quartz and quartz-carbonate veins, and nine samples of metasomatite and skarn. Table 18 of Appendix 2 lists the results of the trace element geochemical analysis. The samples are subdivided according to formation or rock type.

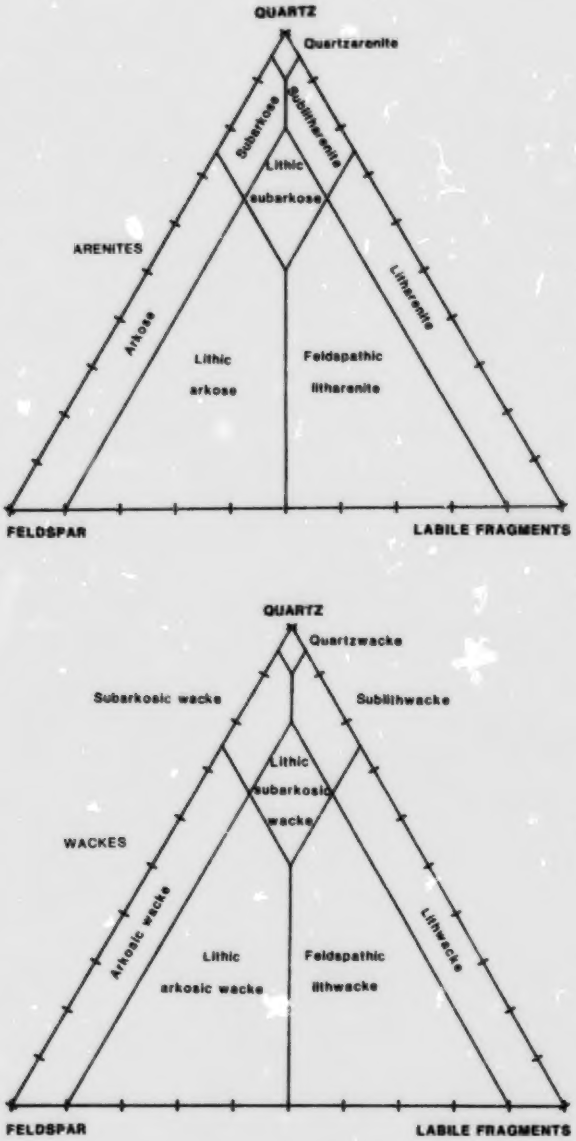


Figure 4. Classification of sandstones (Young 1967).

General Geology

Geological mapping of this area has been done by a number of workers, including Fairbairn (1939), Thomson (1961), Grant et al. (1962), Innes (1978) and Dressler (1982, 1984a, 1987).

Stratigraphic, sedimentologic and petrographic studies of the Huronian Supergroup in areas adjacent to the southern Cobalt Embayment were described in reports by Meyn (1973), Card et al. (1977), Card (1978) and Dressler (1982, 1984b, 1986). The stratigraphic sequence established and used by these workers is listed in Table 1.

The general distribution of the various groups present in the southern Cobalt Embayment is indicated on the simplified geological map shown in Figure 2. The Huronian Supergroup is located within the Southern Province. It is bounded on the north by exposures of underlying Archean granitic, metasedimentary and metavolcanic basement rocks of the Superior Province; on the northwest by exposures of the Sudbury Igneous Complex and Creighton, Murray and Skead plutons; and on the southeast by structurally juxtaposed metasedimentary and intrusive rocks of the Grenville Province. Nipissing gabbro intrusive bodies, which occur throughout the Huronian succession, have been omitted from the map.

The Huronian Supergroup is an Early Proterozoic assemblage of sedimentary and volcanic rocks, which overlaps northward onto a basement of Archean rocks of the Superior Province. The sequence was deposited between 2500 Ma, the minimum radiometric age of Archean felsic plutonic basement rocks, and 2150 or 2160 Ma, the radiometric age of intrusive Nipissing gabbro bodies (Van Schmus 1965; Fairbairn et al. 1969). Direct radiometric dating of Huronian sedimentary and volcanic rocks suggests that they were deposited approximately 2300 Ma (Fairbairn et al. 1969; Knight 1965).

Southwest of Wanapitei Lake, the Huronian succession includes, from the base upwards, rocks of the Stobie, Copper Cliff, McKim and Ramsay Lake formations. Along the west shore of the lake, however, those formations are absent. Strata here correlate with the Matinenda Formation and unconformably overlie Arch-

TABLE 1. STRATIGRAPHY OF THE HURONIAN SUPERGROUP.

HURONIAN SUPERGROUP

Cobalt Group

Bar River Formation – sandstone, siltstone
Gordon Lake Formation – siltstone, argillite, sandstone
Lorrain Formation – sandstone, minor conglomerate and siltstone
Gowganda Formation – conglomerate, argillite, siltstone, sandstone

Local Disconformity

Quirke Lake Group

Serpent Formation – sandstone, siltstone, limestone, conglomerate
Espanola Formation – limestone, dolostone, siltstone, sandstone
Bruce Formation – conglomerate, sandstone, siltstone

Local Disconformity

Hough Lake Group

Mississagi Formation – sandstone, siltstone, argillite, conglomerate
Pecors Formation – siltstone, argillite, sandstone
Ramsay Lake Formation – conglomerate, sandstone, siltstone

Local Disconformity

Elliot Lake Group

McKim Formation – argillite, siltstone, sandstone
Matinenda Formation – sandstone, siltstone, argillite, conglomerate
Copper Cliff Formation – rhyolite, dacite, felsic intrusions, porphyry, crystal tuff, pyroclastics, minor metabasalt and metasediments
Stobie Formation – metabasalt, fragmental mafic metavolcanics, mafic schist, metasediments
Salmay Lake Formation – metabasalt, fragmental mafic metavolcanics, metasediments
Elsie Mountain Formation – metabasalt, minor metasediments

ean basement. A major change in the depositional history of the Huronian Supergroup clearly takes place in the southern Cobalt Embayment.

Because of the areal distribution of the formations of the Huronian Supergroup in the southern Cobalt Embayment, no complete section is present in any one area. No true total cumulative thickness can be determined.

Much of the Huronian Supergroup consists of cyclical repetitions of tripartite sequences of conglomerate, siltstone and wacke, and arenite. This cyclicity has led to the stratigraphic subdivisions used to describe the Huronian succession. The lowermost group is the only one which does not include the tripartite sequence.

Four formations of the Elliot Lake Group are present in the study area. They comprise a sequence approximately 2850 m thick consisting of mafic volcanics (Stobie Formation), felsic volcanics (Copper Cliff Formation), wacke and arenite (Matinenda Formation), and wacke and siltstone (McKim Formation). The Stobie Formation consists of massive and pillowed mafic metavolcanic flows, with rare mafic lithic tuffs and pyroclastic breccias. Locally derived monomictic orthoconglomerate and rare lenses of polymictic orthoconglomerate are also present. The Copper Cliff Formation is made up of quartz-feldspar crystal tuff, massive to flow-banded rhyolite and lapilli tuff to pyroclastic breccia. The Matinenda Formation consists of poorly sorted, discontinuous beds of wacke, arenite and pebble conglomerate. The McKim Formation consists of medium-bedded greywacke and thinly bedded siltstone. Sedimentary structures characteristic of turbidites are present in the McKim Formation.

The Hough Lake Group consists of a tripartite sequence, approximately 3750 m thick, of conglomerate (Ramsay Lake Formation), siltstone to wacke (Pecors Formation) and arenite (Mississagi Formation). The Ramsay Lake Formation consists of massive- to parallel-bedded polymictic paraconglomerate and pebbly wacke. Massive thickly bedded subarkose is present at the top of the formation in McKim Township. The Pecors Formation consists of thinly bedded siltstone, wacke and quartz-feldspar sandstone. Sedimentary structures characteristic of turbidites and fluvial deposits are present at various places in the Pecors Formation. The Mississagi Formation consists almost entirely of thickly bedded medium- to coarse-grained cross-bedded arkose to feldspathic wacke, with minor amounts of interstratified massive- to parallel-laminated siltstone and fine-grained wacke. The sedimentary structures present in it are characteristic of fluvial deposits.

The Quirke Lake Group is approximately 2500 m thick. It repeats the cycle of conglomerate (Bruce Formation), siltstone and wacke (Espanola Formation), and arenite (Serpent Formation) seen in the Hough Lake Group. The Bruce Formation consists of massive, sparsely pebbled polymictic paraconglomerate to pebbly wacke, with interstratified massive and rarely cross-bedded, fine- to medium-grained arkose. The Espanola Formation consists of limestone, parallel-laminated argillite, calcareous siltstone, siltstone to wacke and arkose. The Serpent Formation consists of massive to rarely cross-laminated, medium to thickly bedded arkose and subarkose.

In the study area the Cobalt Group is approximately 1250 m thick. It again repeats the cycle of conglomerate, siltstone and wacke (Gowganda Formation), and arenite (Lorrain Formation). The Gowganda Formation consists of polymictic paraconglomerate to pebbly wacke, siltstone to pebbly siltstone, and wacke to arkose. Siltstone to pebbly siltstone is the predominant rock type. The amounts of wacke and arkose increase near the top of the formation. The Lorrain Formation is made up of arkose, subarkose, silty micaceous arkose and wacke. Cross-bedding is rarely present, but is highlighted in places by graded foresets, and by concentrations of hematite along the foresets.

DEPOSITIONAL ENVIRONMENT OF THE HURONIAN SUPERGROUP

According to Card et al. (1977), Huronian rocks record rapid deposition by facies migration of mainly immature clastic sediments derived from a dominantly felsic plutonic terrane to the north. A variety of depositional environments has been suggested for the Huronian Supergroup. These include deposition on a passive margin facing south or southeast, an aulacogen opening to the east, or a simple elongate graben. Recent suggestions include deposition in a rifted margin (Fralick and Miall 1981), and deposition in a left-lateral strike-slip controlled pull-apart basin related to oblique subduction (Long 1986).

Results obtained from this study suggest that, at least for the Elliot Lake and Hough Lake groups, the depositional environment was submarine, and at the northern edge of a rifted margin. The boundary between terrestrial and submarine conditions crossed the southern part of the area now occupied by the Sudbury Igneous Complex, and continued across northernmost Falconbridge Township. The graben created by the rifted margin was filled by the end of the deposition of the Hough Lake Group. Deposition of the Quirke Lake and Cobalt groups represents deposition of two glacial-marine to fluvial cycles of more widespread distribution.

An unconformity at the base of the Gowganda Formation shows that the Serpent Formation underwent gentle folding and erosion prior to the deposition of the Gowganda Formation. Approximately 20 km north of the southern Cobalt Embayment area, Sauerbrei and Phipps (1983) report an unconformity of greater magnitude where the Gowganda Formation rests directly on the Mississagi Formation, and the entire Quirke Lake Group is missing.

The Stobie and Copper Cliff formations represent parts of a mafic to felsic volcanic sequence deposited along a rifted continental margin. Matinenda Formation deposits were laid down at the end of the volcanism, and lie north of the limit of marine conditions. They were deposited in a braided fluvial environment. Deposits of the McKim Formation are marine, and were deposited from a variety of sediment gravity flows. A submarine fan, possibly at the mouth of an estuary opening from the north, was the source of many of the flows.

The Ramsay Lake Formation was deposited in a glacial-marine environment. Much of it was deposited by debris flows. The decreasing thickness of the formation from south to north (Card et al. 1977), plus the inferred presence of a rifted continent to the south raise the possibility that the deposits of this formation were derived from the south. If the original rifted continent was relatively homogeneous in composition, petrographic studies could neither confirm nor contradict this. The arenites present at the top of the Ramsay Lake Formation in the southern Cobalt Embayment were deposited in a shallow marine environment, and may consist of reworked glacial-marine deposits. The Pecors Formation appears to have been deposited from sediment gravity flows and in channels of a submarine fan. The lowermost and uppermost parts of the Mississagi Formation may have been deposited in a shallow marine environment such as was postulated for the Mississagi Formation in the Sudbury–Espanola area (Card 1969; Palonen 1971). The main part of the Mississagi Formation in the southern Cobalt Embayment appears, however, to have been deposited in a fluvial environment, as was noted by Wood (1980).

The Bruce Formation appears to have been deposited in a glacial and glacial-marine environment. The thickest section of the formation in Falconbridge and Dryden townships is more than 1000 m thicker than the greatest thickness reported elsewhere, and may represent deposition of basal till at the grounding line of a shelf glacier. The Espanola Formation was deposited in a shallow tidal marine environment; the Serpent Formation may have been deposited in a similar environment.

Controversy has surrounded recent interpretations of the role of glaciation in the deposition of the Gowganda Formation (Sharpe 1985; Eyles and Miall 1984). Recent interpretations suggest that the formation consists of debris flows, grain flow deposits, thinly bedded turbidites, and pelagic marine shelf sediments (Miall 1983); and that in the Cobalt Embayment it consists of deep water deposits with little direct glacial influence (Long and Colvine 1985). In the study area the Lorrain Formation appears to have been deposited in a braided fluvial environment.

PALEOFLOW DIRECTIONS – HURONIAN SUPERGROUP

Paleoflow data from eight of the formations present in the southern Cobalt Embayment are summarized in Figure 6. The number of measurements from each formation is indicated at the centre of each rose.

Data from the McKim Formation shown on Figure 6 indicate that flow during deposition was generally to the west, but with a wide range of flow directions. However, in central McKim Township distinct differences exist between flow directions in turbidite beds of proximal and distal facies. Flow in proximal turbidites appears to have been northward and southward in central McKim Township, possibly directed from the margins to the centre of a long, narrow, east-trending basin. Flow in the distal turbidites was westward, along the axis of the basin. Figure 7 shows that this relationship is best developed in the southernmost part of the area. To the north, in the Cambrian Heights area of northeastern McKim Township, flow directions in both proximal and distal turbidites are to the south-southwest. The deposits in this area are typical of those of the midfan regions of submarine fans (Lowe 1979; Walker 1984), and likely represent the deposits of one of a number of fans supplying detritus to the McKim Formation.

One paleoflow indicator was found in the Ramsay Lake Formation, and is shown on Figure 8. It was present in a broad, cross-bedded channel, and may be of only local significance. Flow was to the northwest.

Paleoflow directions in the Pecors Formation are also shown on Figure 8. They are generally to the southwest, with some flow to the southeast and northeast. The depositional environment of the Pecors Formation appears complex. Proximal and distal turbidites as well as apparent fluvial deposits are present in the formation. All these features are, however, compatible with deposition in a submarine fan (Lowe 1979; Walker 1984). Steep-sided channels filled with pebbly wacke present at places within the Pecors Formation may also be found in a submarine fan environment. The different paleoflow directions in turbidites of the Pecors Formation may reflect deposition from different lobes of the submarine fan, while the paleoflow directions present in the "fluvial" deposits of the formation reflect deposition from incised channels on the fan.

Paleoflow directions from the Mississagi Formation show a preferred unimodal orientation on Figure 6. Figure 9 shows that there are, however, local variations in paleoflow directions with location, and with level within the formation. Bimodal flow present in the lowermost and uppermost, more pelitic parts of the formation may indicate deposition in a fluvial-deltaic or shallow marine environment with southeast-flowing depositional currents and southwest-flowing longshore currents. Anomalous paleoflow directions in the uppermost part of the Mississagi Formation south of Ashigami Lake may reflect local depositional constraints. The deposits of the main part of the Mississagi Formation in the southern Cobalt Embayment have unimodal southwest paleoflow directions. They appear to have been deposited by a Platte-type (Ethridge 1980) shallow braided stream.

A few paleoflow directions were determined from arkose interbeds in the Bruce Formation. They are summarized on Figure 6, and are also shown on Figure 10. They show no preferred orientation. The Bruce Formation appears to have been deposited beneath a grounded

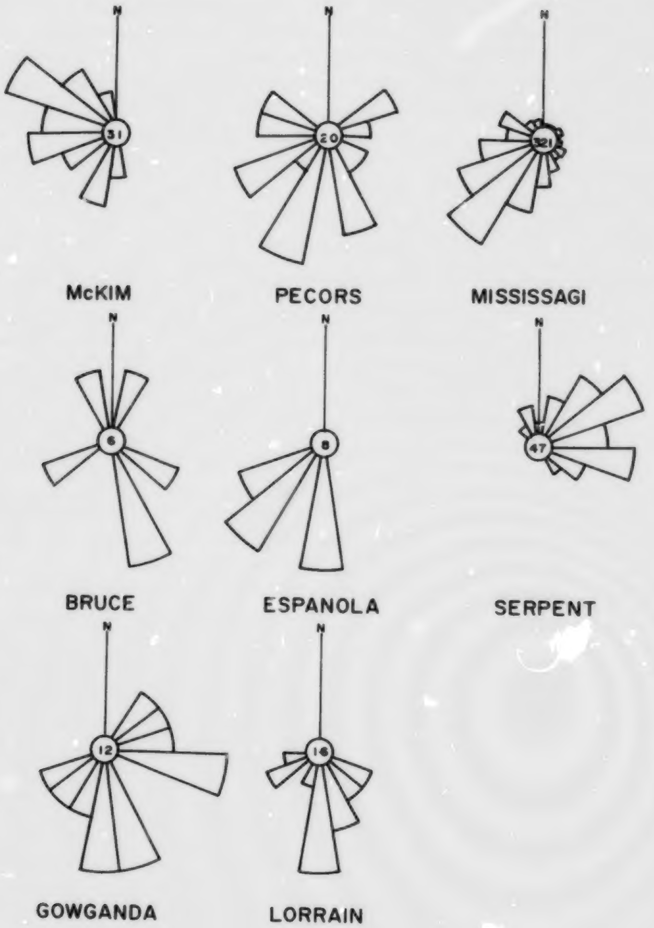


Figure 6. Summary of paleoflow data from the Huronian Supergroup of the southern Cobalt Embayment.

ice shelf, with some glacial-marine deposits present near the top of the formation.

Paleoflow directions in the Espanola Formation are also shown on Figures 6 and 10. They are to the south and southwest. The deposits appear to have been laid down in a shallow-water environment with input from turbidity currents, and near the top of the formation, during periodic subaerial exposure.

Data from the Serpent Formation shown on Figures 6 and 10 indicate paleoflow was mainly to the east-northeast. Weak flow to the northwest was also present. These flow directions are almost opposite to those of most of the Mississagi Formation, but are the same as the anomalous paleoflow directions found in the Mississagi Formation south of Ashigami Lake. The few paleoenvironment indicators observed in the Serpent Formation make interpretation of a depositional environment difficult, but the formation may have been deposited in a shallow tidal shelf setting.

Paleoflow directions obtained from arenites in the Gowganda Formation are also shown on Figures 6 and 10. The paleoflow directions are bimodal to the south and east-northeast. The arenites were likely deposited in a shallow marine environment during the early and late stages of Gowganda deposition.

Data from the Lorrain Formation shown on Figures 6 and 10 indicate that paleoflow was to the south, with weak bimodal flow to the southwest. The arenites of the Lorrain Formation appear to have been deposited by a shallow braided stream.

Rotation of paleoflow directions due to rotation of large blocks of strata by forces related to formation of the Sudbury Breccia and the Sudbury Structure is not thought by the author to have been widespread. Two areas several hundred metres across surrounded by Sudbury Breccia were found to have drastically different paleoflow directions than was normal for their respective formations. Values from those areas were not included in the compilation of paleoflow data. The data compiled come from widely distributed geographic points, have fairly consistent patterns, and show no evidence for rotation.

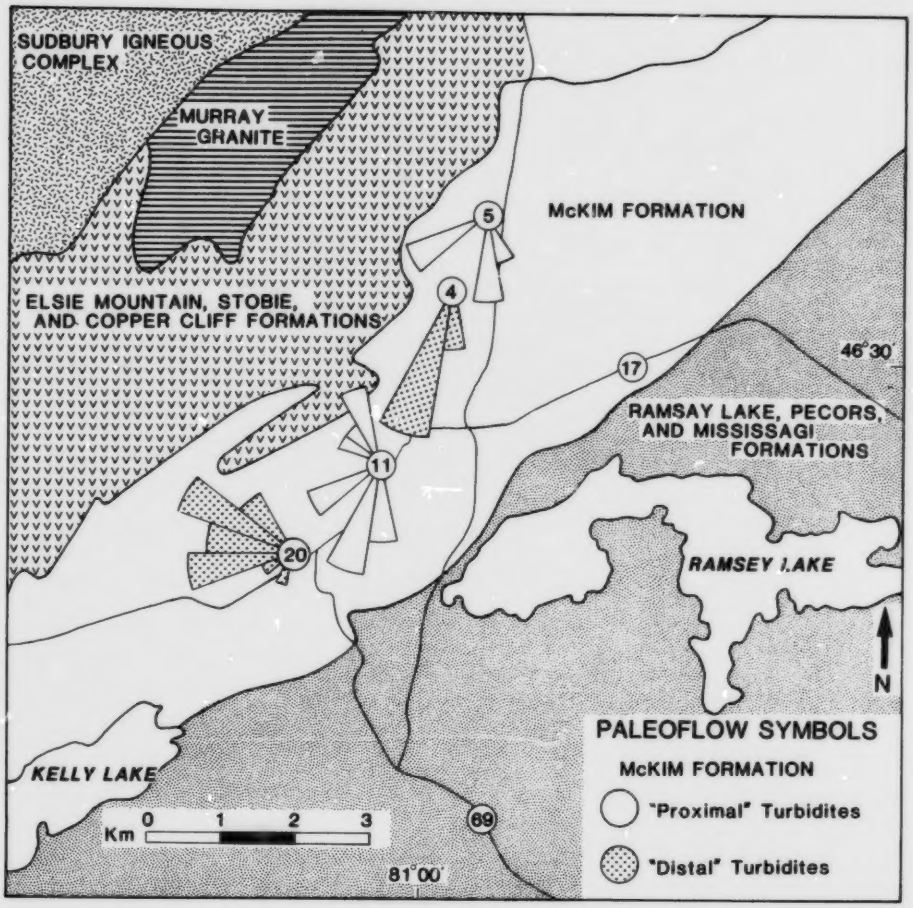


Figure 7. Paleoflow directions for 9 turbidite beds from a submarine fan complex, northeastern McKim Township and 31 other turbidite beds, central McKim Township.

STRATIGRAPHY AND PETROGRAPHY OF THE HURONIAN SUPERGROUP

ELLIOT LAKE GROUP

Two discontinuous volcanic to volcanosedimentary units, and two sedimentary units of the Elliot Lake Group are present in the southern Cobalt Embayment. Both units consist mainly of volcanic rocks, but both have increasing amounts of interbedded volcaniclastic and clastic rocks as the top of the formation is approached. The Stobie and Copper Cliff formations appear to be part of a major mafic to felsic volcanic cycle grading from mafic flows to felsic flows and pyroclastic rocks. Modal analyses from these formations are listed in Table 1 of Appendix 2. The sedimentary units consist of basal conglomerate and associated arenite and wacke, and proximal to distal turbidites and other rocks formed by sediment gravity flows. The Matinenda and McKim formations are found in different parts of the southern Cobalt Embayment. Modal analyses from these formations are listed in Table 2 of Appendix 2. Table 3 of Appendix 2 lists whole rock geochemical analyses for samples from the Elliot Lake Group.

Stobie Formation

INTRODUCTION

Rocks of the Stobie Formation form an east- to northeast-trending belt in McKim, Blezard, Garson and southern Falconbridge townships, and a north-trending belt in northern Falconbridge and Maclennan townships. They consist of dark green to dark grey basalt that weathers dark grey-green, with minor amounts of dacite, siltstone, wacke, subarkose, breccia and conglomerate. The formation is at least 1240 m thick in central Falconbridge Township, but it appears to thin rapidly in the southern part of the township before thickening again in Blezard Township. It also thins rapidly and disappears in central Maclennan Township.

PETROGRAPHY

In central Falconbridge Township, the Stobie Formation consists mainly of massive basalt flows. Pillows up to

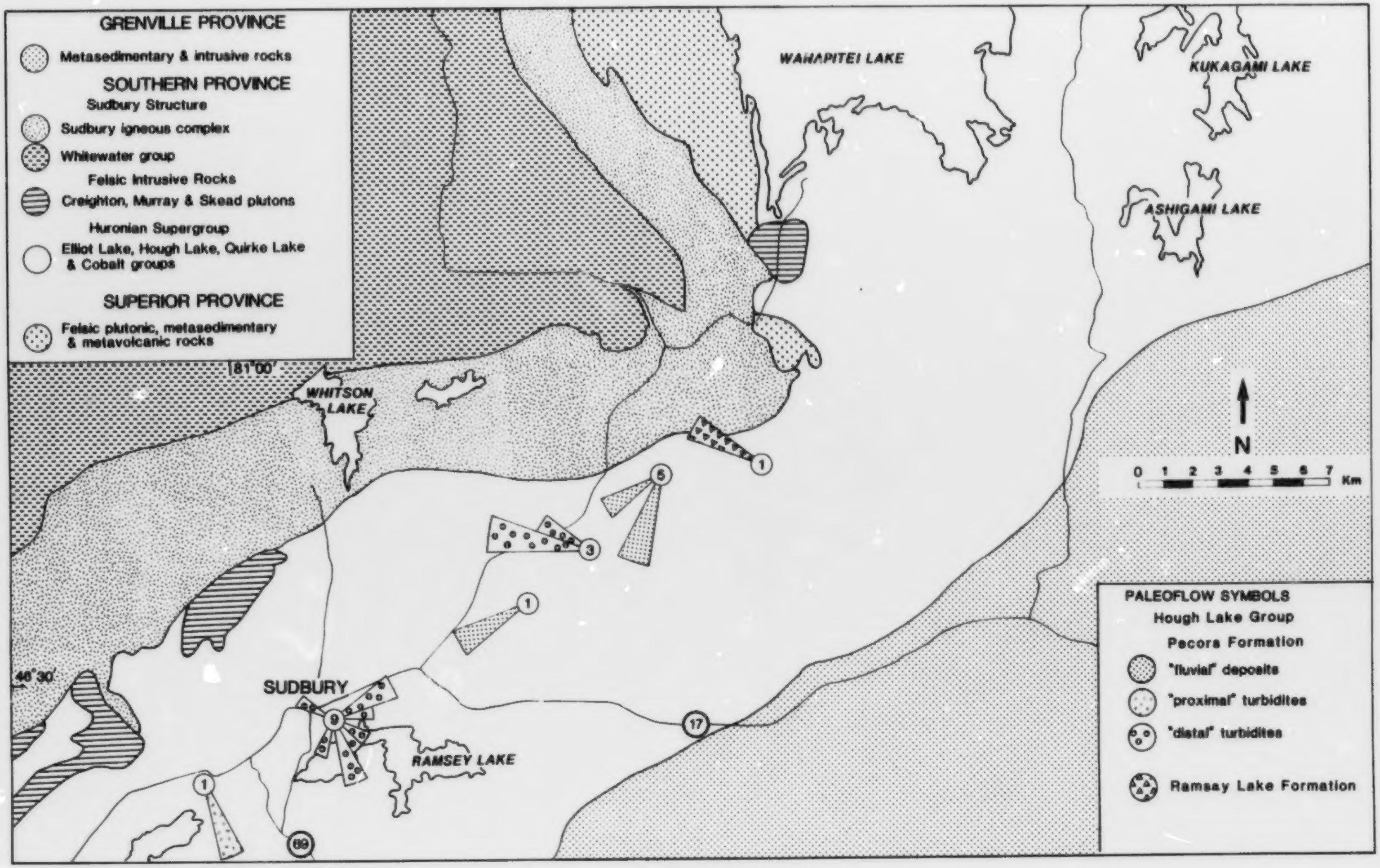


Figure 8. Regional variations in paleoflow directions, Ramsay Lake and Pecors formations.

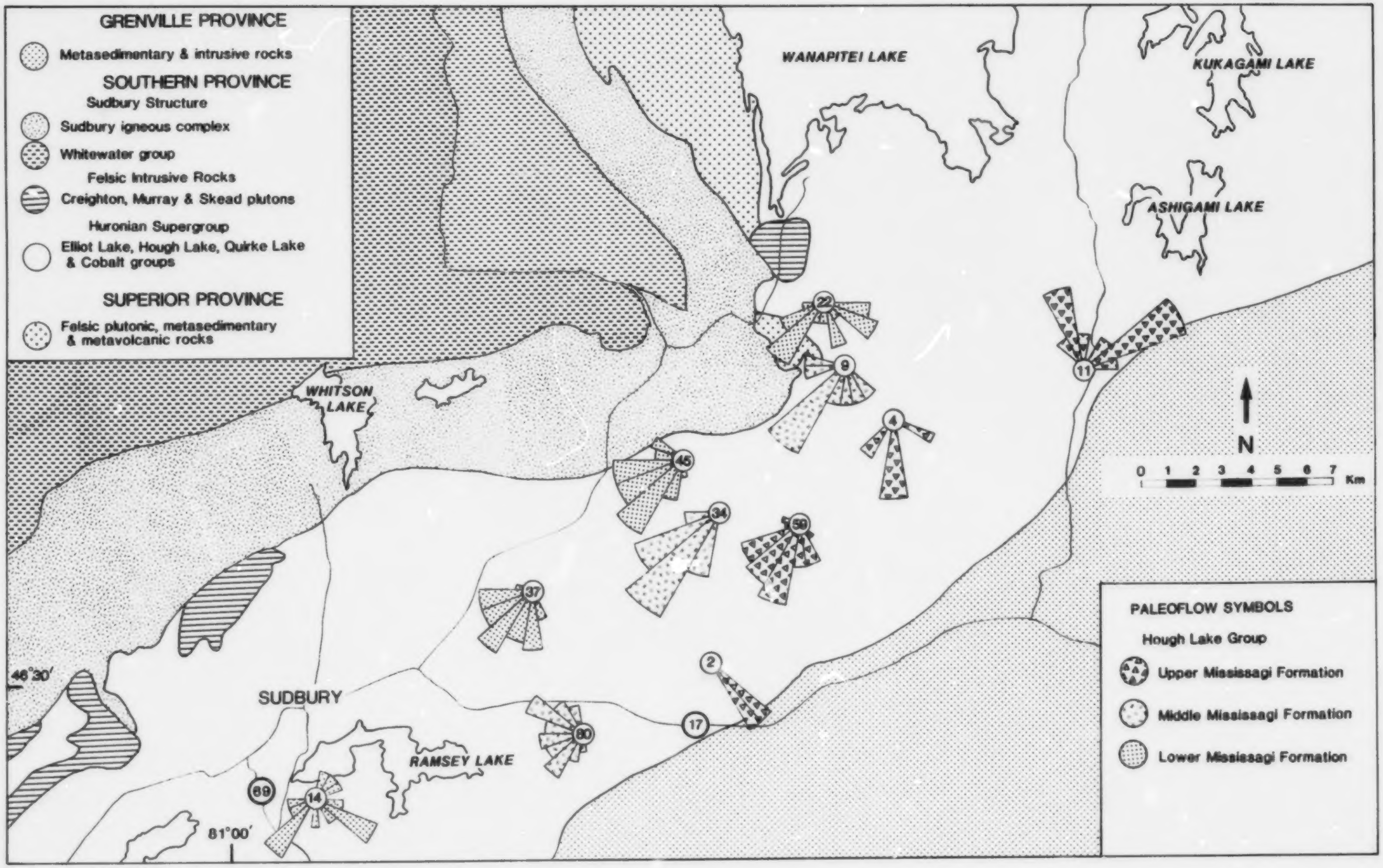


Figure 9. *Regional variations in paleoflow directions, Mississagi Formation.*

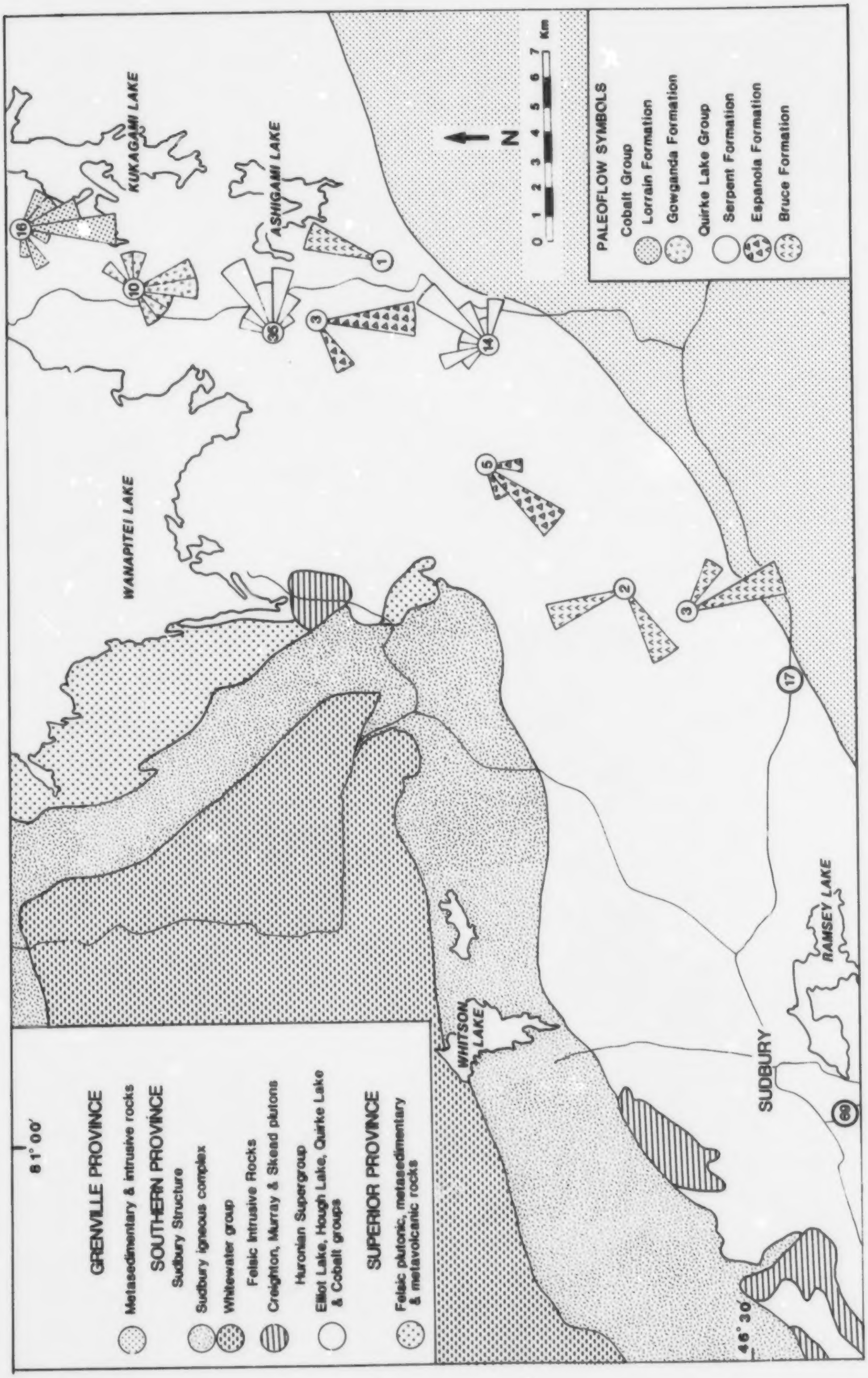


Figure 10. Regional variations in paleoflow directions, Quirke Lake Group and Cobalt Group.

Photo 1. Bedding plane surface of Stobie Formation pillowed basalt (dark) with irregularities in surface filled by siltstone (light). Traverse 27, central Falconbridge Township.

1.5 m across are present in a few places (Photo 1). Both the massive and pillowed flows can be found with or without vesicles or quartz-filled amygdules. Most of the amygdules are 5 mm across or less, but some are up to 5 cm and rarely as much as 15 cm across.

Flow top breccias are present in the uppermost parts of a few of the massive basalt flows. The breccias consist of angular fragments of basalt up to 20 cm across, in a basaltic matrix. Flow banding is visible in the massive basalt immediately below the breccia in some places.

A sequence of dark grey weathering, massive grey dacite approximately 80 m thick is present near the base of the formation. Rare beds of mafic pyroclastics are present in the upper part of the formation and contain tuff breccia with fragments up to 10 cm across, and lapilli tuff in isolated units approximately 1 m thick.

Dark grey dacite present near the base of the formation consists of a very fine-grained intergrowth of plagioclase microlites and micaceous minerals. The microlites show poorly developed trachytoid texture, and are clouded by alteration. Rare plagioclase phenocrysts up to 1 mm long are present, as are glomerophenocrysts of orthoclase with minor microcline. Irregular, monocrystalline quartz grains up to 0.5 mm across, and ragged grains of biotite up to 0.5 mm across are also present.

Siltstone to fine-grained wacke and rare subarkose occur as interflow sediments in the middle and upper portions of the Stobie Formation. They are light to dark grey on weathered and fresh surfaces, and are massive to finely laminated. The subarkose contains faint cross-laminations in a few places. Bed thicknesses range up to 20 cm, but most beds are discontinuous and less than 5 cm thick. Some beds fill irregularities in the surface of the underlying flow. Minor syndepositional slumping is present in the siltstone and wacke.

Siltstone in the Stobie Formation contains parallel laminations 1 to 20 mm apart. Augite laths up to 0.2 mm long, in part replaced by chlorite, are oriented parallel to the laminations. Chlorite is also present in aggregates up to 2 mm across, with altered possible actinolite. These aggregates crosscut the laminations in the siltstone and are of metamorphic origin.

Rare intraformational breccia and polymictic orthoconglomerate are present in the middle and upper portions of the Stobie Formation. The intraformational breccia occurs as beds 0.5 to 3.5 m thick consisting of 50 to 60 percent angular to subangular locally derived volcanic and siltstone fragments in a silty matrix. The fragments are up to 10 cm across, but most are 5 to 6 cm. Some clasts are orientated parallel to bedding. At one location in central Falconbridge Township, a sandstone dike 30 cm across crosscuts, but is confined to, a 3 m thick bed of intraformational breccia.

The conglomerate occurs in beds 3 to 10 m thick consisting of 50 to 60 percent subangular to round fragments of granite, quartz, mafic volcanics, arkose and schistose metasediments in a silty to sandy matrix. The clasts are up to 30 cm across, but most are 4 to 10 cm. Oval and elongate clasts commonly show well-developed imbrication. The characteristics of pebbles and cobbles from one bed of this orthoconglomerate are shown in Figure 11. One conglomerate bed grades

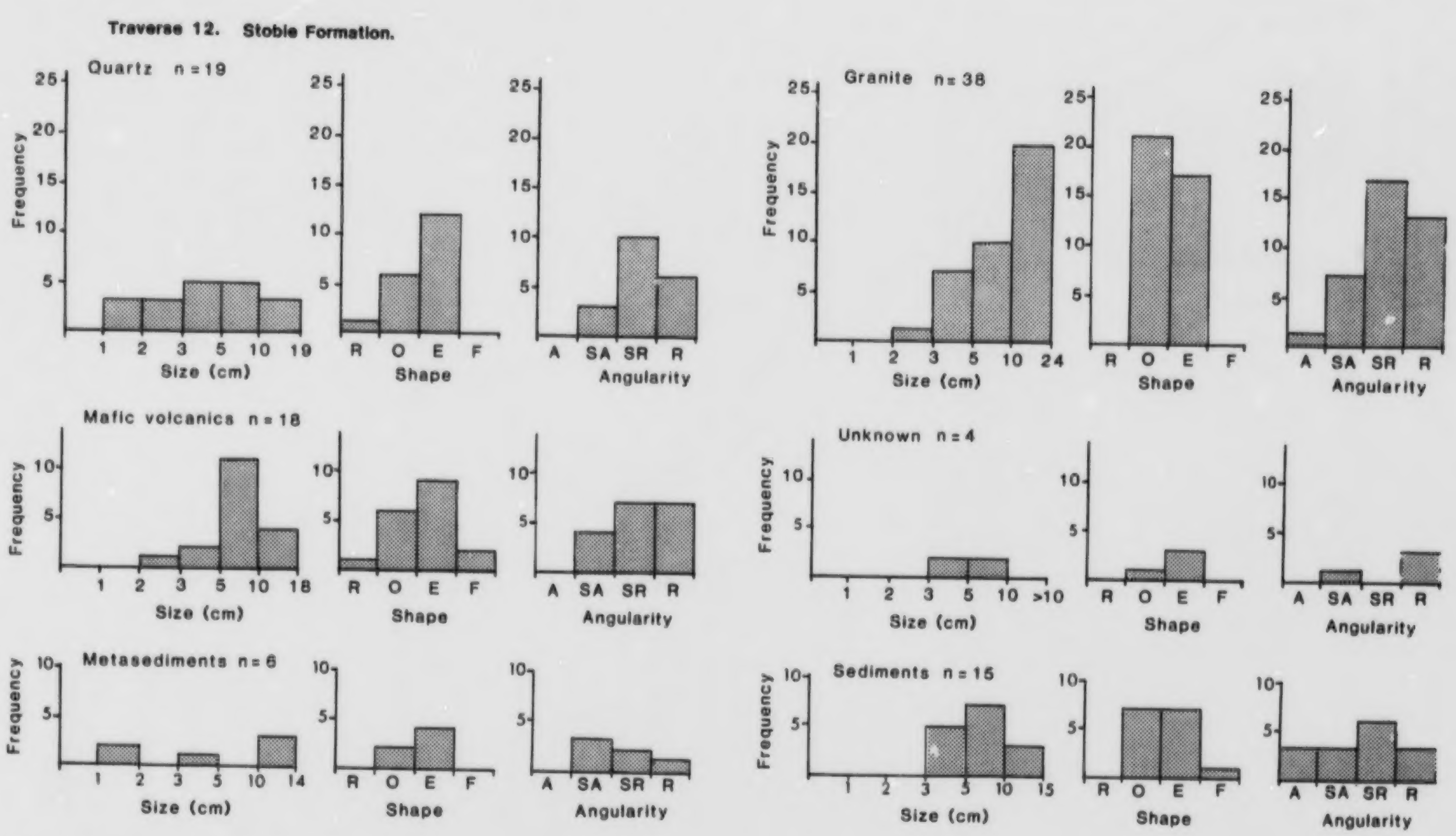


Figure 11. Composition, size, shape and angularity of pebbles and cobbles in Stobie Formation conglomerate.
Shape: R - round, O - oval, E - elongate, F - flat
Angularity: A - angular, SA - subangular, SR - subrounded, R - rounded

upward over 3 m to a fine- to medium-grained, light grey, massive sandstone with rare clasts.

Modal analyses of rocks of the Stobie Formation are presented in Table 1 of Appendix 2 and whole rock geochemical analyses in Table 3 of Appendix 2.

Copper Cliff Formation

INTRODUCTION

Felsic metavolcanics (Photo 2) of the Copper Cliff Formation form a northeast-trending belt in McKim, Blezard and Garson townships. The lower part of the Copper Cliff Formation and the contact between the Copper Cliff Formation and the underlying Stobie Formation are not exposed. The Copper Cliff Formation is made up of quartz-feldspar crystal tuff and felsic lithic tuff to tuff breccia, with minor amounts of flow banded rhyolite, subarkose, wacke and intraformational conglomerate, which are pink to pale grey on their fresh surfaces and pink to tan on their weathered surfaces. The thickness of the exposed section is 300 m in McKim Township, but the formation thins under overburden in Blezard Township, and disappears in southern Garson Township.

PETROGRAPHY

Quartz-feldspar crystal tuff is the most common rock type in the Copper Cliff Formation. It is massive, with quartz phenocrysts up to 1.5 mm and feldspar phenocrysts up to 2.0 mm in size. The flow banded rhyolite is very similar in appearance to the crystal tuff, except that poorly to well-developed flow banding is present.

In the quartz-feldspar crystal tuff, quartz occurs as equant subhedral to euhedral monocrystalline and polycrystalline grains 1 to 4 mm across. Potassic feldspar is present as equant subhedral to euhedral grains 1 to 2 mm across, and plagioclase is present as elongate subhedral to euhedral grains 1 to 2 mm long (Photo 3). The quartz and feldspar phenocrysts make up 5 to 20 percent of the rock. They are enclosed by a quartzofeldspathic allotriomorphic granular matrix, with grains less than 0.1 mm across.

The lithic tuff and tuff breccia consist of subangular to subround fragments of rhyolite in a rhyolitic matrix. The fragments are sometimes difficult to distinguish from the matrix, but on some weathered surfaces the fragments are slightly lighter in colour than the matrix. Fragments range in size from 0.1 to 35 cm, but are most often between 1 and 8 cm. Local variations in fragment size and abundance define crude stratification.

The rhyolitic crystal-lithic tuff is very similar to the quartz-feldspar crystal tuff, but includes 20 to 70 percent lapilli and breccia fragments. The lapilli and fragments are of the same composition and texture as the matrix, but in the sample studied in thin section, the matrix of the fragments is coarser grained than the matrix of the rock surrounding them. The matrix surrounding the fragments consists of allotriomorphic granular quartz, potassic feldspar and plagioclase grains 0.1 to 0.2 mm across, with muscovite 0.1 mm across. Dark brown pleochroic biotite is also present in the matrix.

Arkose, wacke and rare intraformational conglomerate occur as discontinuous beds of irregular thickness in the upper part of the formation. Some beds fill de-

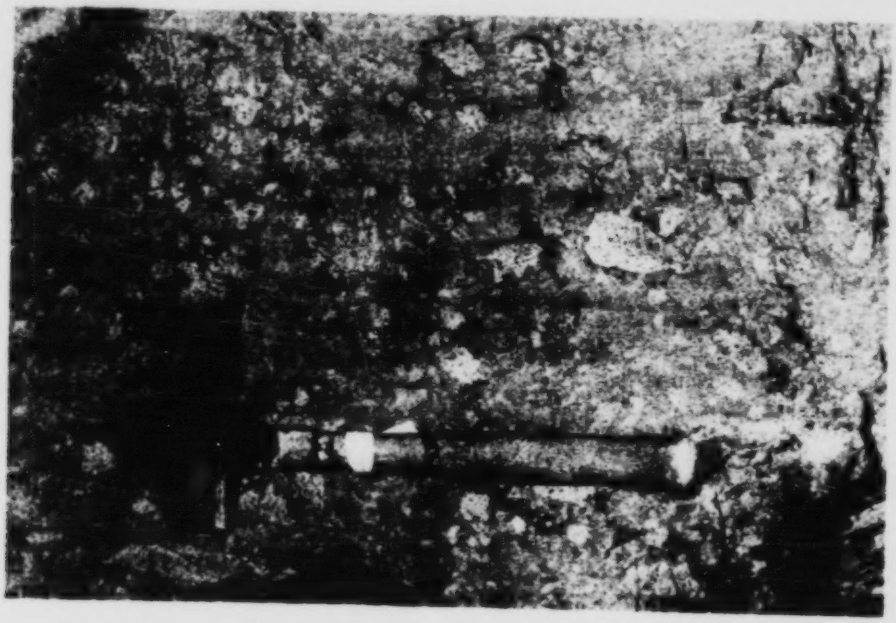


Photo 2. Copper Cliff Formation rhyolitic pyroclastic rock with fragments slightly lighter in colour than matrix. Traverse 53, central McKim Township.

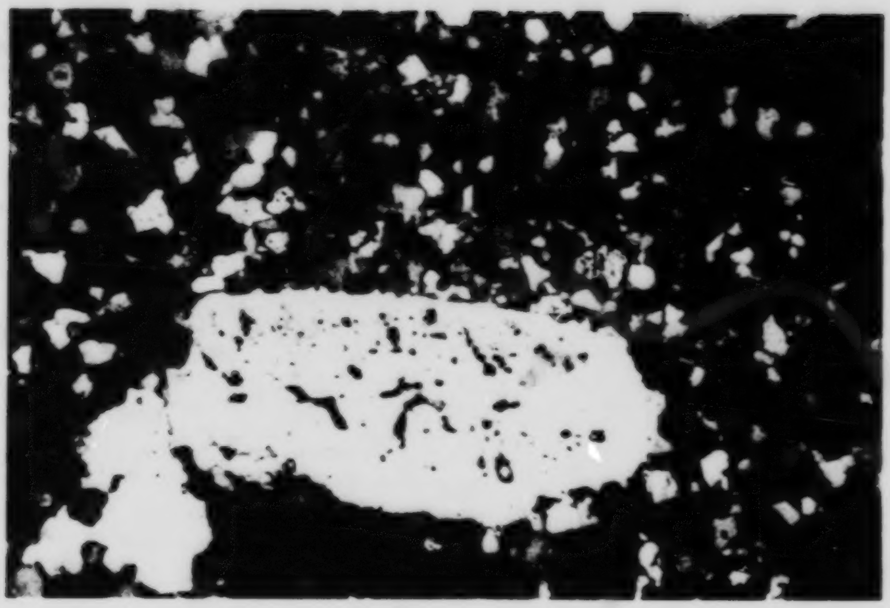


Photo 3. Plagioclase phenocryst with poorly developed antiperthitic texture in allotriomorphic granular matrix, Copper Cliff Formation. Crossed polarizers, field of view 2 mm across. Sample 86RLD-5302, Traverse 53, central McKim Township.

pressions in the surface of the underlying rhyolite horizon. The arkose and wacke consist of varying amounts of very fine- to coarse-grained quartz and feldspar in a silty fine-grained matrix, and occur in massive to parallel-laminated beds with laminations 0.5 to 3 cm apart. The conglomerate is matrix to clast supported, with 20 to 60 percent clasts. It consists of subangular elongate clasts of rhyolite in a fine-grained wacke matrix. The clasts are usually less than 2 cm, but locally up to 50 cm across, and are oriented parallel to bedding. Poorly developed parallel lamination is present in the matrix.

Arkose to arkosic wacke in the Copper Cliff Formation are believed by the author to be derived from the volcanic rocks of the formation. They consist mainly of very fine-grained equant quartz, potassic feldspar and minor plagioclase grains. Quartz grains 0.5 to 5 mm across and rare potassic feldspar grains up to 0.25 mm across derived from phenocrysts in the rhyolites make up 5 to 10 percent of the rock. Muscovite is present as very fine to fine grains. In one sample, a poorly defined parallel fabric is defined by muscovite. In another, matted muscovite makes up as much as 70 percent of oval patches up to 3 mm across, but only 5 percent of the rest of the rock. It is most likely that much of the muscovite is a product of metamorphism. Poikiloblastic grains of chlorite from 1 to 5 mm across in one sample (86RLD-5306) may also be a product of metamorphism.

Units of massive to parallel-laminated arkose to wacke up to 15 m thick in the upper 100 m of the Copper Cliff Formation along Traverse 53 (*see* Figure 3) may be part of a thick transition zone from the Copper Cliff Formation into the overlying McKim Formation, or may be part of the McKim Formation, with rhyolite juxtaposed above it along a Sudbury Breccia body.

Matinenda Formation

INTRODUCTION

Rocks tentatively assigned to the Matinenda Formation are found in Maclennan Township in discontinuous patches south and southwest of Wanapitei Lake. The rocks are not clearly correlative with the Matinenda Formation, but because they are separated from the Mississagi Formation by parallel-laminated argillaceous siltstone, and because they form basal conglomerates, they have been assigned to the Matinenda Formation. They consist of pink conglomerate, arkose and wacke that weather pink to tan in colour. The patches of Matinenda Formation rocks are less than 20 m thick. In places, they rest unconformably on Archean granitic rocks, while elsewhere they overlie Stobie Formation basalt. Where the Matinenda Formation overlies Archean granitic rocks, conglomerate rests on a scoured surface of fresh granite in one place, while several hundred metres away, arkose rests on a discontinuous layer of coarse-grained quartzofeldspathic grus up to 10 cm thick over granite with weak supergene alteration to a depth of 3 m. Where the Matinenda Formation overlies Stobie Formation basalt, a poorly exposed patch of conglomerate up to 2 m thick rests on the top of the basalt.

PETROGRAPHY

The conglomerate occurs in lenses from 10 to 30 cm thick, and rarely as much as 60 cm thick. The lenses are from 2 to 10 m long. Where the conglomerate overlies

Archean granitic rocks, it consists of oligomictic orthoconglomerate, with more than 90 percent white quartz clasts, minor dark grey quartz clasts and rare wacke and siltstone clasts in an arkosic to arkosic wacke matrix. The clasts are subangular to round, and usually less than 5 cm across, although subangular to round clasts up to 10 cm across and rare angular clasts up to 30 cm across are present. In the lowermost beds, a few granitic clasts up to 15 cm across are also present. Some conglomerate beds grade upward or laterally into medium-grained arkose or wacke. Where the conglomerate overlies Stobie Formation basalts, it consists of polymictic paraconglomerate, with quartz, granite, siltstone and wacke clasts up to 15 cm across in a silty wacke matrix.

The arkose and wacke consist of poorly bedded and laterally discontinuous units 5 to 30 cm thick, which have vertical and lateral grain size gradations ranging from fine to very coarse.

The compositions of three samples are indicated on Figure 12. All three are sublithwacke. They range from fine grained with 5 percent granular material, to coarse grained. In places the sublithwacke contains a few subangular to subrounded pebbles of white quartz and black chert. Pyrite is subrounded, and very fine to medium grained. It appears to be concentrated in bands approximately 1 mm thick in beds without pebbles, and around the base of pebbles in pebbly beds. Trace amounts of carnotite are present, especially where pyrite is also present. The sublithwacke contains 38 to 56 percent angular to rounded quartz, with 17 to 32 percent monocrystalline quartz, and 6 to 28 percent polycrystalline quartz. The monocrystalline grains range from 0.1 to 2 mm across, and have abundant vacuoles and rare acicular and vermicular mica inclusions. They were likely derived from vein quartz sources. The polycrystalline quartz grains range from 0.2 to 3 mm, and are rarely up to 30 mm across. Some grains contain abundant fluid inclusions while others contain few. The polycrystalline quartz was likely derived from several sources, including vein quartz, granitic rocks and metasedimentary rocks such as recrystallized chert. The sublithwacke contains from 0 to 4 percent microcline, and from 1 to 2 percent plagioclase. The feldspar grains are subrounded and equant to oval, and range in size from 0.1 to 2 mm. Weak sericitic alteration is present in the microcline. The plagioclase is strongly sericitized. Lithic fragments of four types make up 11 to 16 percent of the sublithwacke. They occur in grains 0.2 to 10 mm across. Fine-grained granite fragments are most common. Massive siltstone and fine-grained sandstone fragments are also common. Subangular to subrounded feldspar-quartz-muscovite schist fragments, possibly derived from foliated granitic rocks are present in places, as are mafic metavolcanic rock fragments. Two to 5 percent anhedral to euhedral opaque grains from 0.05 to 0.5 mm across, as well as smaller "specks" are present. Both types appear to be preferentially concentrated in interstitial areas. Brown micaceous matrix makes up 23 to 44 percent of the rock. Modal analyses of rocks of the Matinenda Formation are presented in Table 2 of Appendix 2.

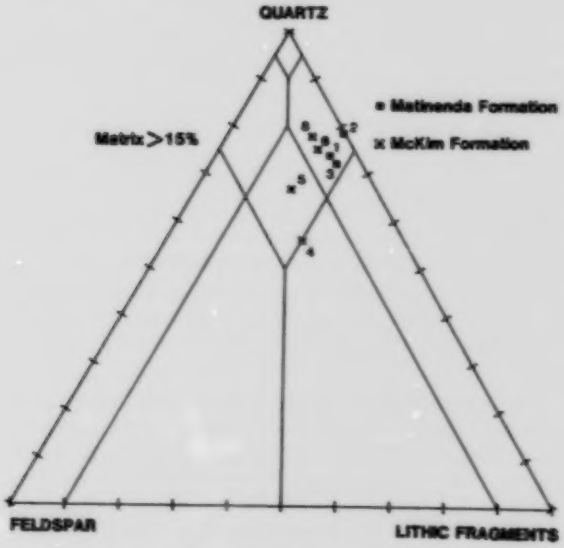


Figure 12. Composition of Matinenda and McKim formation wackes.

McKim Formation

INTRODUCTION

Rocks of the McKim Formation form a northeast-trending belt from McKim Township across Neelon, Garson and part of Falconbridge townships. The formation is at least 1300 m thick in McKim Township, where the lower and middle parts of it are exposed. The McKim Formation thins under overburden in Neelon and Garson townships, and disappears in Falconbridge Township.

In McKim and part of Garson townships, the McKim Formation overlies the Copper Cliff Formation. The contact between the two is conformable and gradational. The McKim Formation overlies the Stobie Formation in part of Garson Township and Falconbridge Township, but that contact is not exposed.

PETROGRAPHY

The rocks of the McKim Formation consist of siltstone and fine- to coarse-grained wacke that are buff to grey-brown and grey-green on their fresh surfaces and buff to tan, grey and greenish grey on their weathered surfaces.

The siltstone and wacke of the McKim Formation are typical of the deposits of various types of sediment gravity flows, and represent proximal and distal turbidites, fluidized flows, grain flows and cohesive debris flows (classification after Lowe 1979). Proximal and distal turbidites (Photo 4) are the most common deposits. Coarser-grained material is more common in the lower part of the formation and in the eastern part of the area of exposure, while finer-grained material is more common in the upper part of the formation and in the western part of the area of exposure.

Photo 4. Distal turbidite beds in McKim Formation with parallel lamination, and parallel lamination–ripple cross-lamination–parallel lamination sequences. Traverse 60, Cambrian Heights area, north-central McKim Township.

Distal turbidites present in the McKim Formation consist of siltstone to fine-grained wacke in beds 2 to 30 cm thick. Most beds are 3 to 10 cm thick, and have planar bed contacts without scour marks. Parallel-laminated wacke is present at the base of each bed. The parallel-laminated wacke grades upward into ripple cross-laminated wacke in some beds, and the cross-laminated wacke rarely grades upward into parallel-laminated wacke. In rare cases, parallel-laminated argillite beds up to 5 mm thick are present between the distal turbidite beds.

Proximal turbidites present in the McKim Formation consist of fine- to coarse-grained wacke in beds 10 to 130 cm thick. Most beds are 30 to 70 cm thick. Bed contacts are sharp to indistinct, and scours, flame structures, load casts and rip-up clasts to 10 cm across are present at the base of a few beds. Most beds are massive to graded. In a few cases, the graded beds grade upward into parallel-laminated wacke. The parallel-laminated wacke rarely grades upward into ripple cross-laminated wacke. Parallel-laminated argillite beds up to 2 cm thick are present between the proximal turbidite beds in rare cases.

Rocks representing fluidized flows occur in the lower part of the McKim Formation in northern McKim Township. They consist of fine- to medium-grained wacke and rare arenite in beds 20 to 200 cm thick. Most beds are 50 to 100 cm thick. Bed contacts are often indistinct, and many have scours as much as 50 cm deep. Concentrations of round very coarse quartz grains are present at or near the base of some beds. Most beds consist of massive wacke, but the central to upper portions of a few beds contain poorly developed dish structures. Parallel laminations are present in the uppermost portions of a few beds.

Rocks representing grain flows in the McKim Formation consist of medium- to coarse-grained wacke, and occur in beds 15 to 50 cm thick. Bed thicknesses are variable, as some bed contacts are scoured. Some beds are discontinuous. In places, only discontinuous scours filled with massive coarse-grained wacke remain. In addition to scours, injection structures up to 50 cm long are present at the base of some beds. Most beds are massive, but some beds have faint reverse grading in the lower 1 to 2 cm of the bed, and some have faint normal grading near the top of the bed. A crude parallel orientation of elongate coarse grains is present in places. The uppermost parts of some beds, including discontinuous beds, have cross-beds with amplitudes up to 10 cm.

Debris flows are also present in the McKim Formation. They consist of medium- to coarse-grained wacke in beds 20 to 200 cm thick, but in most cases the beds are 50 to 100 cm thick. The beds are poorly graded, and in places have diffuse parallel laminations near the base of the beds.

The compositions of four samples are indicated on Figure 12. Two samples are of sublithwacke, and there is one sample of each of lithic subarkosic wacke and feldspathic lithwacke. The wacke is fine- to coarse-grained, and poorly sorted. It contains 30 to 65 percent quartz, with 16 to 30 percent monocrystalline quartz and 26 to 45 percent polycrystalline quartz. The monocrystalline quartz is angular to subangular, and irregular in shape. It ranges from 0.1 to 1 mm in size and contains few to no

Photo 5. Polycrystalline quartz grains in quartz-feldspar-mica matrix, McKim Formation. Crossed polarizers, field of view 2 mm across. Sample 86RLD-6002, Traverse 60, Cambrian Heights area, north-central McKim Township.

inclusions. The polycrystalline quartz is subangular to subround and irregular in shape. It ranges in size from 0.2 to 3 mm. Intragrain boundaries are irregular to polygonal. Four to 14 percent of potassic feldspar is present in the wacke. It is present as equant to oval, weakly altered, fine to coarse poikilitic grains. Plagioclase makes up less than 1 percent of the wacke. It occurs as subrounded, equant to oval fine and rarely medium grains. It has poorly developed twinning, and in places is antiperthitic. The composition of the plagioclase is An_{24-48}. The monocrystalline quartz, at least part of the polycrystalline quartz (Photo 5), and the potassic feldspar and plagioclase were likely derived from crystal tuff of the underlying Copper Cliff Formation. The remainder of the polycrystalline quartz may have been derived from recrystallized rocks. Lithic fragments are present in three of the samples. They are subangular to subrounded, equant to oval, and fine to very coarse grained. Biotite makes up 1 to 13 percent of the wacke. It is fine grained and pleochroic, and occurs in grains of irregular shape with irregular orientation. Chlorite is present in four of the samples, and makes up 2 to 10 percent of them. The chlorite grains are fine grained and bladed, and generally occur as replacements of biotite. Matrix makes up 21 to 41 percent of the wackes analyzed. It consists of silt-sized grains of quartz, feldspar and muscovite, with minor amounts of chlorite, biotite and opaque minerals. Muscovite is generally absent, or present only in small amounts, but one sample contains 21 percent. The muscovite occurs as large, ragged poikilitic grains, some of which are twinned. This muscovite is metamorphic in origin. Modal analyses of rocks of the McKim Formation are presented in Table 2 of Appendix 2 and a whole rock geochemical analysis in Table 3 of Appendix 2.

HOUGH LAKE GROUP

The Hough Lake Group is the lowermost of three tripartite sequences which make up the rest of the Huronian Supergroup in the southern Cobalt Embayment. The tripartite sequences consist of conglomeratic rocks at the base, overlain by argillaceous rocks, and topped by arenaceous rocks. In the Hough Lake Group, the Ramsay Lake Formation comprises the conglomeratic rocks. The argillaceous rocks are present in the Pecors Formation, and the arenaceous rocks are present in the Mississagi Formation. Modal analyses from these formations are listed on Table 4 of Appendix 2. Table 5 of Appendix 2 lists whole rock geochemical analyses for samples from the Hough Lake Group.

Ramsay Lake Formation

INTRODUCTION

Rocks of the Ramsay Lake Formation form a northeast-trending belt across McKim, Neelon, Garson and Falconbridge townships. In central Falconbridge Township, the belt swings north, and the formation thins and disappears. The Ramsay Lake Formation consists of dark grey to grey-brown, massive to parallel-bedded polymictic paraconglomerate, pebbly wacke and wacke that weather tan to dark grey. Massive arenite that is tan coloured on both weathered and fresh surfaces is present at the top of the formation in McKim Township. The Ramsay Lake Formation appears thickest in the Minnow Lake area of McKim Township, but the apparent thickness of more than 550 m in that area may be due to the presence of extensive bodies of Sudbury Breccia. Elsewhere in McKim Township, the Ramsay Lake Formation is more than 385 m thick. The formation thins to the southwest and to the northeast from McKim Township, and disappears in northern Falconbridge Township.

The Ramsay Lake Formation overlies the McKim Formation in McKim, Garson and the southern part of Falconbridge townships, and overlies the Stobie Formation in the northern part of Falconbridge Township. The contact between the Ramsay Lake Formation and the McKim Formation is covered, or intruded by Nipissing gabbro almost everywhere in the study area. In the one place it was found in outcrop, the contact is sharp and conformable. A 20 cm thick unit of polymictic paraconglomerate with 30 percent granitic, mafic volcanic and quartz clasts in a wacke matrix marks the base of the formation. It is overlain by a 3 m thick unit of sparsely pebbled conglomerate, which grades upward into massive to parallel-bedded pebbly wacke and conglomerate. Coarse- to very coarse-grained glassy grey quartz grains appear for the first time in the Huronian succession in the matrix at the base of the Ramsay Lake Formation. The contact between the Ramsay Lake and Stobie formations is not exposed.

PETROGRAPHY

Conglomeratic rocks in the Ramsay Lake Formation range from pebbly wacke to polymictic orthoconglomerate. The pebbly wacke contains up to 5 percent clasts from 1 to 5 cm in size in a fine- to medium-grained wacke matrix. Polymictic paraconglomerate typically contains 10 to 15 percent clasts from 1 to 15 cm across, with some clasts up to 30 cm and rarely as much as 150 cm across, in a fine- to medium-grained wacke matrix. In most places, the matrix contains 5 to 10 percent of grey to blue, medium- to very coarse-grained quartz. Because of the local development of hornfels, the matrix is micaceous in a few places. Clasts consist of granite, mafic metavolcanic rock, quartz, and less commonly, metagabbro, metasedimentary rocks and rare pyritic metasedimentary rocks. Most of the pyritic metasedimentary clasts noted were in Falconbridge Township. The various clasts are equant to oval in shape, and are subangular to subround. Orthoconglomerate is present in a few isolated horizons containing up to 70 percent clasts, within thick units of typical paraconglomerate. The pebbly wacke and conglomerate range from massive to parallel bedded, with diffuse parallel bedding defined by variations in clast abundance. The parallel beds range from 5 to 100 cm thick, but most are 20 cm thick or less. They occur within thick, otherwise coherent conglomeratic units. Sharp planar to undulating bed contacts, sometimes with scours present, occur between conglomeratic units in a few places. Most of the clasts are oriented with their long axis parallel to bedding, but in a few places, some flat clasts were found oriented perpendicular to bedding while other clasts in the same bed were parallel to bedding. Cross-stratification is present in the pebbly wacke, but it is very rare.

Fine-grained wacke is present as rare interbeds in the upper part of the formation. Northeast of McKim Township, where the sandstone member at the top of the formation is absent, the wacke occurs in units up to 2 m thick, and is massive to parallel bedded with beds 1 to 3 cm thick. It is interbedded with conglomerate, and both wacke and conglomerate channel into underlying beds in places. In McKim Township, graded wacke beds 20 to 80 cm thick, with concentrations of coarse grains at the base, are interbedded with conglomerate below the sandstone member.

Fine- to coarse-grained subarkose occurs as interbeds near the top of the conglomeratic section of the Ramsay Lake Formation in McKim Township, and forms a distinct sandstone member approximately 45 m thick at the top of the formation in the southern part of the township. The sandstone member immediately overlies a 2 m thick bed of massive boulder conglomerate with clasts up to 60 cm in size in a wavy laminated wacke matrix (Photo 6). Near the base of the section, coarse-grained arenite is present in cuspate lenses up to 5 cm long and 2 cm high, within fine- to medium-grained arenite. The lenses look like infillings of symmetrical wave ripples. Beds in the sandstone member are 5 to 100 cm thick, and are massive to parallel laminated. Some beds have scoured bases.

Rare dropstones are present in all the units throughout the formation.

The compositions of three wacke specimens are indicated on Figure 13. One is a lithwacke, one is a sublithwacke, and one is a lithic subarkosic wacke. All three form the matrix of pebbly wacke to conglomerate. The wacke is fine to coarse grained and poorly sorted, with granules present in some places. It contains 17 to 50 percent quartz, with 2 to 24 percent monocrystalline quartz and 15 to 43 percent polycrystalline quartz. The monocrystalline quartz is fine to medium grained. The grains are subrounded and oval, and contain very few inclusions. They were likely derived from rocks of the Copper Cliff Formation. The polycrystalline quartz is fine grained to granular. The grains are subangular to subrounded, and oval to elongate. Some contain only a few subgrains, with irregular intragrain boundaries. Others contain scores of subgrains, with interlocking grain boundaries. They were likely derived from metamorphosed chert. From 0 to 8 percent potassic feldspar is present in the wacke. It is fine to medium grained and weakly altered, and occurs as subrounded oval grains. The wacke also contains from 0 to 2 percent plagioclase. The plagioclase is fine to coarse grained, and occurs in subangular to subrounded, equant to oval, fresh to weakly sericitized grains. The composition of the plagioclase is An_{38-54}. It may have been derived from phenocrysts in the Copper Cliff Formation. Lithic fragments make up from 1 to 22 percent of the wacke. Medium-grained to granular lithic fragments are present, and they grade into pebble-sized clasts. The grains are subangular to subrounded, and oval to flat. Granitic

Photo 6. Massive boulder conglomerate which underlies the sandstone member of the Ramsay Lake Formation in McKim Township. Traverse 57, south-central McKim Township.

rock fragments and fragments of siltstone and arenite are most common, but felsic to intermediate volcanic and diabase fragments are also present. The composition, size, shape and angularity of pebbles from one sample of pebbly wacke are shown on Figure 14. Ramsay Lake Formation wacke contains from 0 to 2 percent muscovite, from 0 to 6 percent biotite and from 0 to 3 percent chlorite. All micaceous minerals are fine to medium grained. The muscovite is very pale green in colour, and the biotite is strongly pleochroic. The chlorite appears to be secondary after biotite. From 22 to 55 percent matrix is present in the wacke.

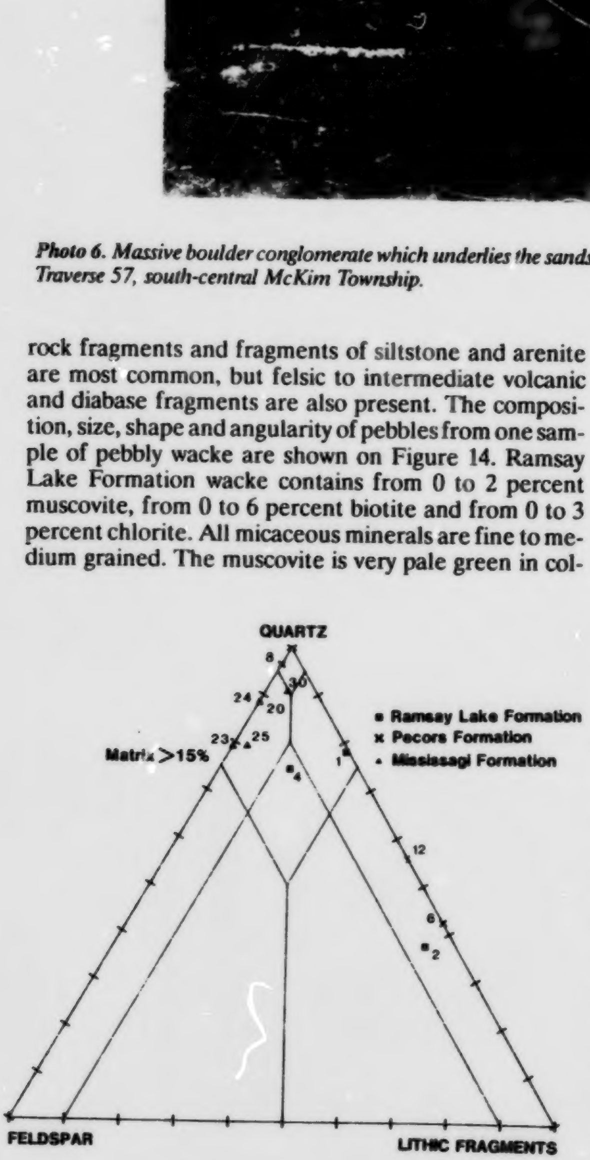


Figure 13. Composition of Hough Lake Group wackes.

The composition of the Ramsay Lake Formation subarkose is shown on Figure 15. It contains 74 percent quartz, with 40 percent monocrystalline quartz and 34 percent polycrystalline quartz. The monocrystalline quartz is fine to coarse grained, and occurs in subrounded, oval grains. It contains a few vacuoles and acicular inclusions. It may have been derived from plutonic sources. The polycrystalline quartz is fine to coarse grained, with only a few subgrains per grain. It occurs in subrounded, oval grains. The subarkose contains 13 percent potassic feldspar, which is present as fine to coarse, subrounded oval grains. It is weakly sericitized. Two percent plagioclase is also present as fine to coarse, subrounded oval grains. Fine- to medium-grained lithic fragments make up 1 percent of the rock, and consist of felsic volcanic and granitic rock fragments. Approximately 2 percent of detrital muscovite and biotite, and chlorite after biotite are also present. Matrix makes up 8 percent of the Ramsay Lake Formation subarkose.

Modal analyses of rocks of the Ramsay Lake Formation are presented in Table 4 of Appendix 2 and whole rock geochemical analyses are presented in Table 5 of Appendix 2.

Pecors Formation

INTRODUCTION

The Pecors Formation forms a northeast-trending belt across McKim, Neelon, Garson and southern Falconbridge townships. Rocks correlated with the Pecors For-

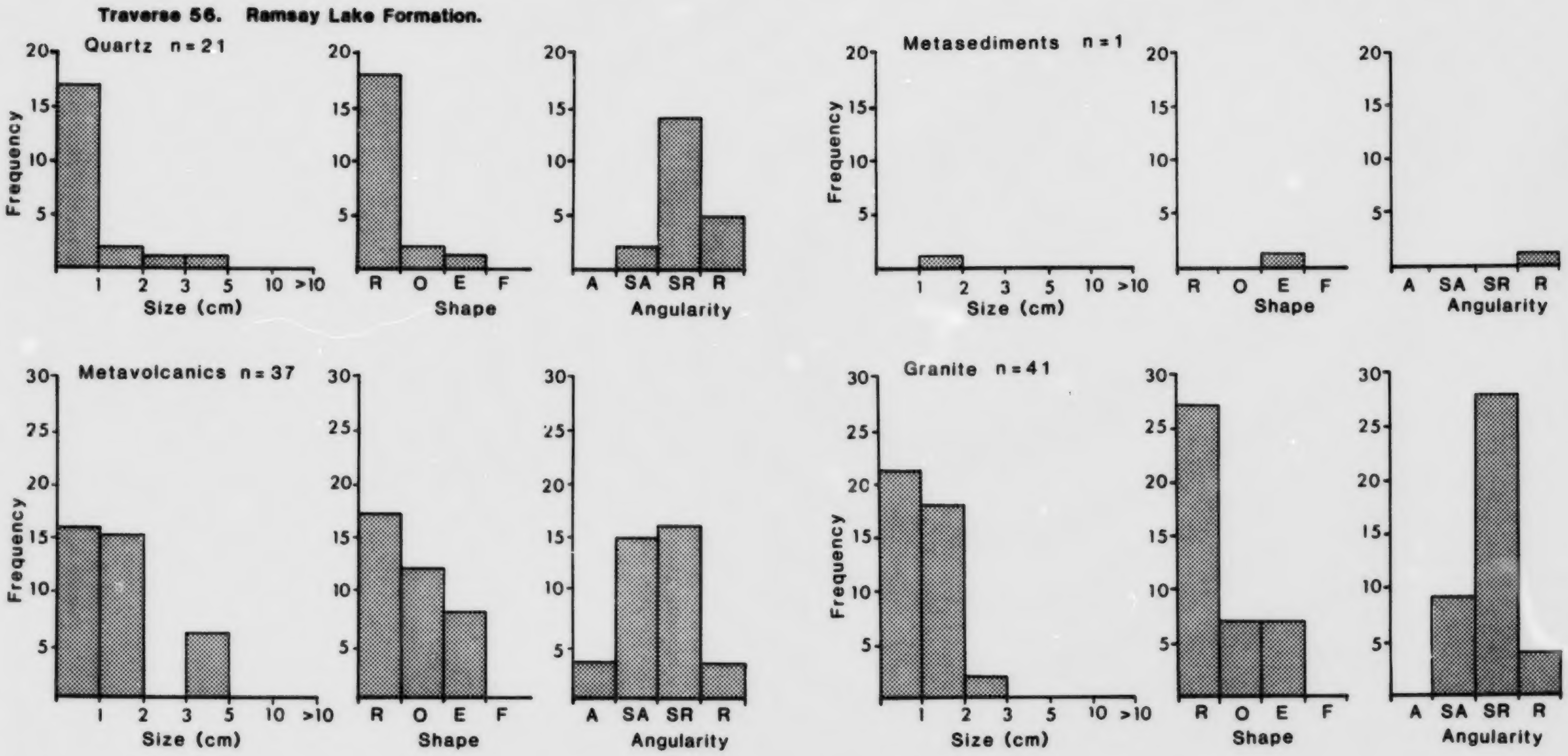


Figure 14. Composition, size, shape and angularity of pebbles in Ramsay Lake Formation pebbly wacke.
Shape: R - round, O - oval, E - elongate, F - flat
Angularity: A - angular, SA - subangular, SR - subrounded, R - rounded

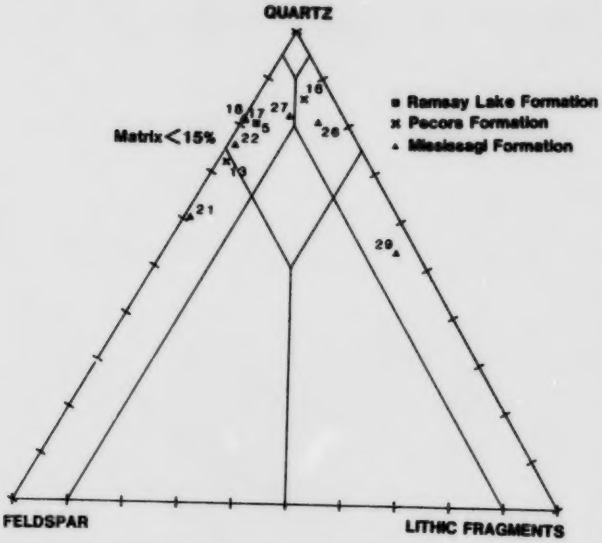


Figure 15. Composition of Hough Lake Group arenites.

mation also occur in discontinuous patches south and southwest of Wanapitei Lake in Maclennan Township. Grey to tan and buff siltstone, wacke and arenite that weather grey to buff, are present in the Pecors Formation. The formation appears to be thickest in McKim Township, but because much of it is covered, or disrupted by faults, accurate thicknesses cannot be determined. The thickest section measured is in Neelon Township; it is 280 m thick. The formation thins rapidly in Garson Township, but thickens again before disappearing in Falconbridge Township. The discontinuous patches of Pecors Formation in Maclennan Township are up to 60 m thick.

In McKim, Neelon, Garson and Falconbridge townships, the Pecors Formation overlies the Ramsay Lake Formation. The contact is gradational across several metres both where the Pecors Formation overlies conglomerate and wacke, and where it overlies subarkose. In places rare dropstones are present in the lowermost few metres of the Pecors Formation. In Maclennan Township, where the Pecors Formation overlies the Matinenda Formation, the contact is abrupt but conformable. Parallel-laminated siltstone overlies medium-grained arkose topped by irregular ripples up to 1 cm high.

PETROGRAPHY

Siltstone in the Pecors Formation is laminated, with parallel laminations 1 to 15 mm thick. In places lenses and laminations of very fine-grained sand including starved ripples with amplitudes up to 5 mm are interbedded with the siltstone.

Distal turbidites in the Pecors Formation (Photo 7) occur as discontinuous to continuous beds 10 to 30 cm thick, consisting of very fine- to fine-grained wacke. They contain parallel laminations and poorly developed ripple cross-laminations with amplitudes from 0.2 to 5 cm. Load casts are present at the base of some beds.

Very fine- to medium-grained wacke is present in massive to graded beds 1 to 10 cm thick with parallel bed

Photo 7. Interbedded distal turbidites and very fine-grained graded wacke in the Pecors Formation. Traverse 51, southwestern McKim Township.

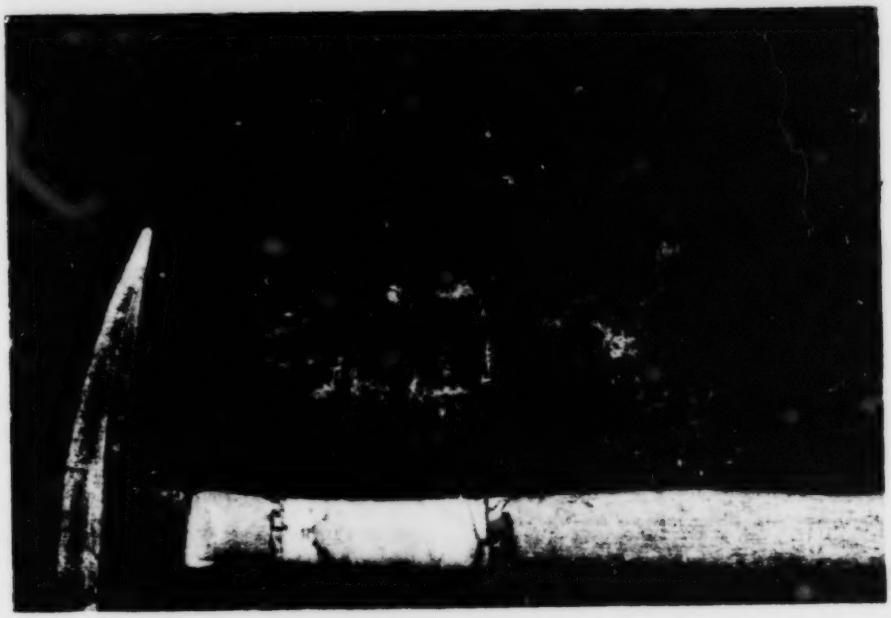


Photo 8. Load casts and flame structures at the base of a proximal turbidite in the Pecors Formation. Traverse 37, south-central Garson Township.

contacts. The wacke may represent poorly developed proximal turbidites. Well-developed proximal turbidites in the Pecors Formation occur as massive fine- to medium-grained wacke beds 30 to 60 cm thick. Load casts (Photo 8), flame structures, rare rip-up clasts, and possible shallow channels are present at the base of some beds. The proximal and distal turbidites occur as interbedded sequences.

Minor amounts of fine-grained arenite are present in beds up to 20 cm thick, with fine parallel laminations in some places and planar cross-beds in others.

Rare channels containing conglomeratic rock are also present. In McKim Township, a channel only 8 cm deep contains pebbly, fine-grained wacke. In Falconbridge Township, a channel 1.5 m deep contains polymictic paraconglomerate with quartz, mafic volcanic, metasedimentary and rare granite clasts. The clasts are oval to elongate, subangular to round, and from 1 to 10 cm across; most are from 1 to 3 cm across. Parallel bedding and large scale cross-bedding are present in this conglomerate, and the clasts are very well imbricated. A channel with very steep sides is present near the top of the formation in Garson Township. The channel is 7.5 m across and 12.5 m deep, and is filled by lenticular beds of sandstone and quartz pebble conglomerate with quartz pebbles up to 2 cm across. The quartz pebbles are oval to equant, so no imbrication is present.

Polymictic paraconglomerate also occurs in a discontinuous bed 30 cm thick in the lower part of the Pecors Formation in McKim Township. Elongate clasts in the conglomerate are oriented perpendicular to bedding, possibly indicating that it was deposited by a debris flow.

Modal analyses of four samples of siltstone are listed in Table 4 of Appendix 2. The siltstone is parallel laminated, with laminations from 0.05 to 10 mm thick. The laminations are marked by different relative abundances of quartz, feldspar and mica, and individual laminations contain from 30 to 100 percent matrix. Very faint normal grading, and faint reverse grading followed by normal grading, is present in some laminations. Tiny ripple cross-laminations up to 3 mm high are also present. The siltstone contains 95 to 99 percent "matrix". The siltstone also contains very small amounts of biotite and 0 to 2 percent chlorite. The biotite and chlorite are very fine to fine grained. Most, if not all of the chlorite is secondary after biotite. One to 5 percent opaque minerals are also present. They are anhedral, and bladed to equant. They occur preferentially in thin layers one to two grains thick at the base of beds with normal grading, and mark the foresets of the tiny cross-laminations. The thin layers of opaque minerals are surrounded by rusty stains in some samples.

The compositions of three samples of wacke are shown on Figure 13. There is one sample of quartz-wacke, and two of lithwacke. They range from very fine grained to very coarse grained. The quartz content of the wackes is 22 to 72 percent. The quartz grains are very fine to very coarse grained, but most often are fine grained. The larger grains may be polycrystalline, but it is difficult to confirm due to suturing along intergrain boundaries caused by compaction. Up to 2 percent potassic feldspar and 1 percent plagioclase are present in

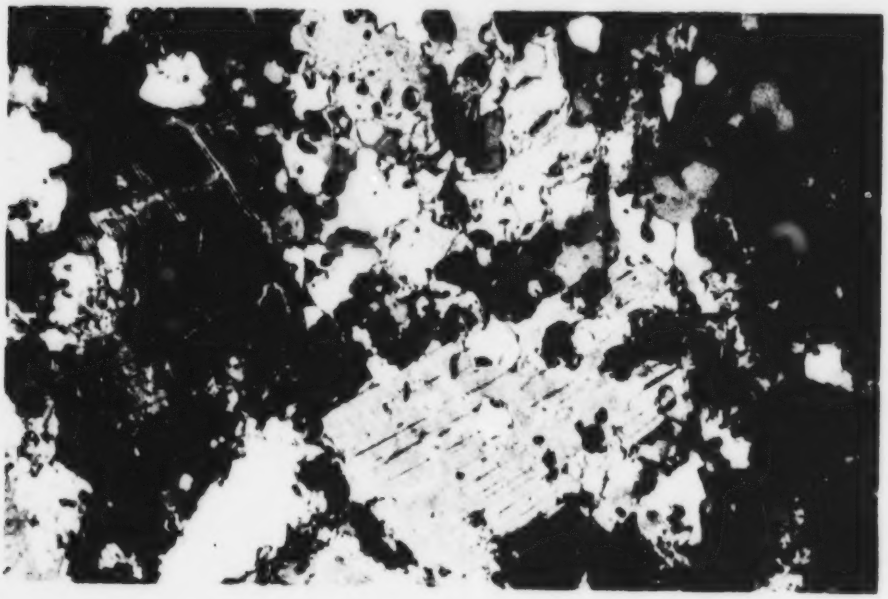


Photo 9. Poikiloblastic muscovite in Pecors Formation metasediment. Crossed polarizers, field of view 2 mm across. Sample 86RLD-1503, Traverse 15, north-central Neelon Township.

the coarsest-grained sample. The feldspar grains are medium to coarse, and have weak alteration. One sample contains 1 percent fine-grained granitic lithic fragments. Some samples contain no mica, while others contain up to 24 percent muscovite, small amounts of biotite, and up to 21 percent chlorite. The mica is very fine to fine grained, with chlorite secondary after biotite. The wackes contain 18 to 53 percent matrix. The matrix is brown, and includes biotite, muscovite, chlorite and other silt-sized particles. Only minor amounts of opaque minerals are present in two of the samples, but in the other, 8 percent are present. They occur as individual or agglomerated anhedral grains, and occur preferentially concentrated along the base of graded laminations. One contact metamorphosed sample of wacke from a location adjacent to a Nipissing gabbro body contains 11 percent scapolite in oval blebs 5 mm long. The blebs are formed from interlocking aggregates of poikiloblastic grains, with rare subhedral and twinned grains present.

The compositions of two samples of arenite are shown on Figure 15. A third sample, containing 33 percent coarse- to very coarse-grained poikiloblastic muscovite (Photo 9) was not included with the arenites because it has been metamorphosed. The arenites contain 65 and 74 percent quartz, with 48 and 52 percent monocrystalline quartz, and 13 and 25 percent polycrystalline quartz. The monocrystalline quartz occurs as fine to coarse, subangular to subrounded, equant to elongate grains. The polycrystalline quartz occurs as subangular, oval to elongate fine grains to granules and small pebbles. Potassic feldspar makes up 5 to 19 percent, and plagioclase makes up a trace to 4 percent of the arenites. All the feldspars occur as subangular to subrounded, equant to elongate, fine to medium grains, and are weakly altered. The plagioclase composition is An_{25-59}. Minor amounts of fine-grained muscovite and chlorite after biotite are present. The sublitharenite contains 5 percent lithic fragments. The lithic fragments occur as rounded, oval medium grains to granules and small pebbles. Most of the lithic fragments are of fine-grained diabase, but some siltstone fragments are also present. The matrix of the arenites consists of silt-sized quartz, feldspar and chlorite grains. Rare abraded, very fine grains of zircon are present in the arenite.

The composition, size, shape and angularity of pebbles in one sample of conglomerate from a cross-bedded channel 2 m deep are shown on Figure 16. The clasts in this channel have a well-defined preferred orientation parallel to the dip of the cross-bed foresets.

Modal analyses of rocks of the Pecors Formation are presented in Table 4 of Appendix 2 and whole rock geochemical analyses in Table 5 of Appendix 2.

Mississagi Formation

INTRODUCTION

Rocks of the Mississagi Formation form a broad northeast-trending band across McKim, Neelon, Garson and Dryden townships. In these townships, the formation is disrupted by numerous faults. In Falconbridge Township, the formation swings north, and then crosses Falconbridge and Maclennan townships. The Mississagi Formation is also present in a fault-bounded block in southern Scadding Township on the south side of Ashigami Lake. It consists of tan to grey, medium- to

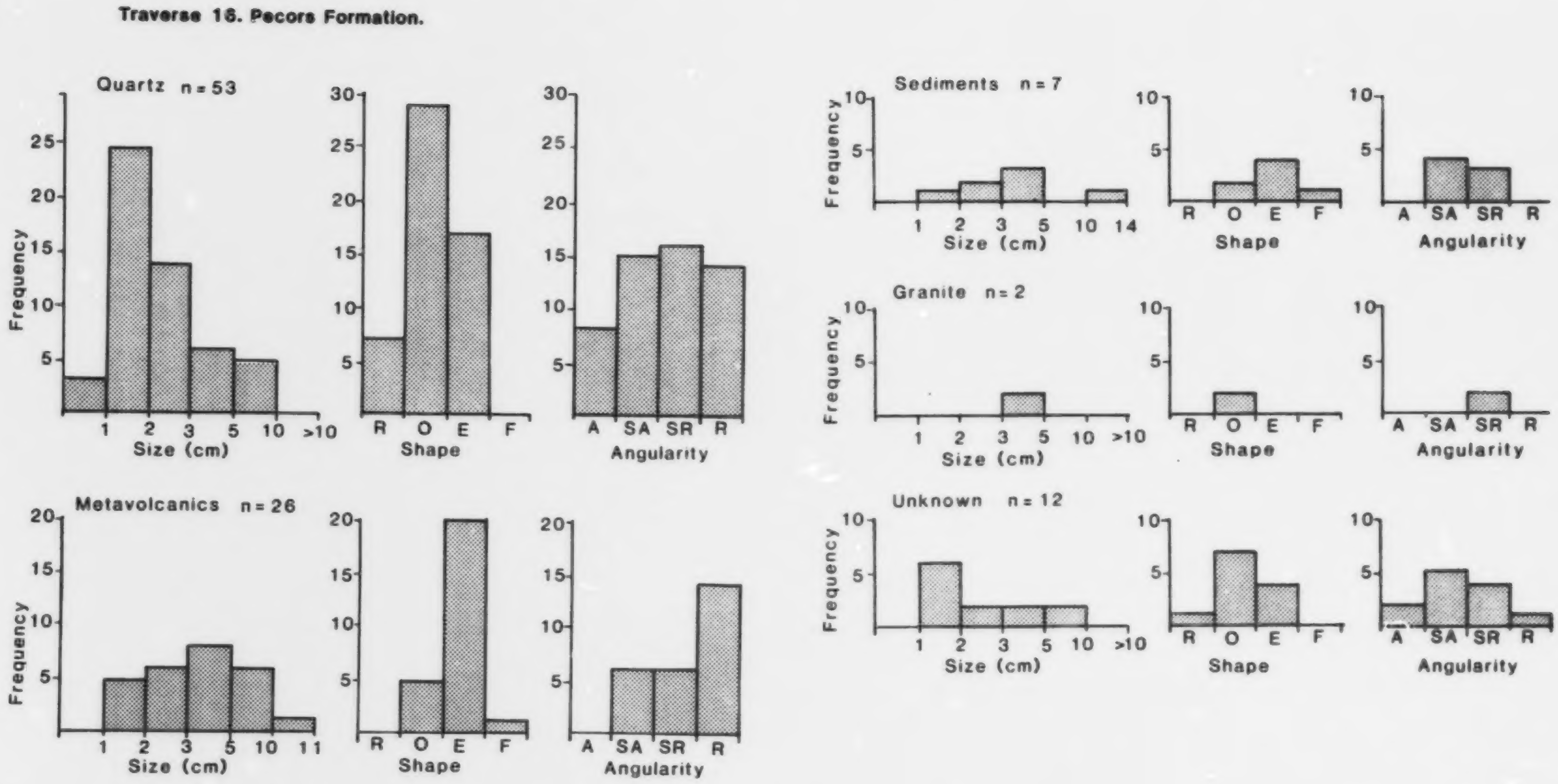


Figure 16. Composition, size, shape and angularity of pebbles in Pecors Formation pebbly wacke.
Shape: R - round, O - oval, E - elongate, F - flat
Angularity: A - angular, SA - subangular, SR - subrounded, R - rounded

coarse-grained arenite that weathers tan to buff, grey and rusty in colour, with minor amounts of fine- to medium-grained wacke and siltstone. An accurate thickness of the formation cannot be determined in McKim, Neelon, Garson and Dryden townships due to the faulting there, but the formation is 3080 m thick in southern Falconbridge Township. It appears to thin northward as the underlying units do, but poor exposure in Maclennan Township precludes confirmation of this.

The Mississagi Formation overlies the Pecors Formation in McKim, Neelon and southern Falconbridge townships. The contact is abrupt and conformable. The lowermost Mississagi Formation in these areas consists of 20 to 75 m of distinctive, massive to parallel-laminated to wave-rippled, fine- to medium-grained arenite in beds 10 to 100 cm thick. This arenite does not occur elsewhere in the formation. In central Falconbridge Township, the Mississagi Formation overlies the Ramsay Lake Formation. The contact there is not exposed, and the lower 50 to 100 m of the Mississagi Formation in the area consists of fine-grained, massive to parallel-bedded arenite with silty interbeds, overlain by massive, medium-grained arenite. In northern Falconbridge Township and parts of Maclennan Township, the Mississagi Formation overlies the Stobie Formation. That contact is not exposed. The Mississagi Formation also overlies the Pecors Formation in discontinuous patches in Maclennan Township. The contact there is abrupt, and conformable to disconformable with shallow channels. The lowermost Mississagi Formation in this part of the study area consists of coarse-grained, parallel-bedded arenite.

PETROGRAPHY

The Mississagi Formation consists mainly of thickly bedded cross-stratified, medium- to coarse-grained arenite to wacke with minor amounts of interstratified, massive to parallel-laminated siltstone and fine-grained wacke. The siltstone and fine-grained wacke interbeds are most common in the lower 250 m of the formation, immediately above the massive to parallel-laminated arenite at the base, and in the uppermost 500 m of the formation. In the uppermost 500 m of the formation, the siltstone and wacke interbeds make up as much as 30 percent of the rock. The siltstone and fine-grained wacke interbeds are generally less than 10 cm thick, although some beds are as much as 20 cm thick. In many places, they fill shallow channels in the top of the underlying bed, or are cut by channels at the base of the overlying bed. The medium- to coarse-grained arenite to wacke occurs in beds 10 to 150 cm, and rarely as much as 200 cm thick. Most beds are tabular, although rare lenticular beds are present in the middle part of the formation. In the lower 250 m of the Mississagi Formation, most beds are 10 to 60 cm thick. Bed thicknesses increase to 50 to 120 cm throughout most of the formation, and then decrease to 10 to 80 cm in its uppermost 500 m.

Many different types of depositional features are present in the Mississagi Formation. Some are quite complex. They include planar cross-laminations and cross-beds, trough cross-beds and cross-laminated cross-beds. Two types of megaripples with amplitudes from 3 to 10 cm, but usually from 5 to 7 cm, are also present. Straight-crested ripples form tabular units, while lunate-crested megaripples form lenticular units. Both types make up beds in some places, but in other places, they clearly form the foresets of large planar cross-beds. The foresets are at angles of 5° to 20° to bedding, and most often are at angles of 10° to 15° to bedding. A different type of cross-laminated cross-bed is also present. In this type, cross-laminated cross-beds are bounded by convex-upward reactivation surfaces (Photo 10). In almost every case, the cross-laminations dip more steeply than the reactivation surfaces, but rare beds in which the cross-laminations dip less steeply than the reactivation surfaces are present. Straight-crested and lunate megaripples, and all three types of cross-laminated cross-beds are most common in the lowermost 250 m of the Mississagi Formation, although they occur in places in the middle of the formation and are common in the uppermost 500 m of the formation. Throughout the formation, many of them are associated with broad, shallow channels.

Planar cross-beds, trough cross-beds and cosets of the two are also present in the lower 250 m of the Mississagi Formation, but are most common in the middle part of the formation. Planar cross-beds are most usual. They occur as one set per bed, so have amplitudes of 20 to 150 cm. Some planar cross-beds have graded foresets. Many beds contain cosets with one set of planar cross-beds in the lower half to two-thirds of the bed, overlain by trough cross-beds (Photo 11). Beds consisting entirely of trough cross-beds (Photo 12), and of cosets grading from trough to planar and back to trough cross-beds are less common. Distorted cross-beds are present in a few places in the middle and upper parts of the formation.

The compositions of five samples of wacke are indicated on Figure 13. All five of the wacke samples are of subarkosic wacke. They contain 34 to 50 percent quartz, with 16 to 33 percent monocrystalline quartz, and less than 1 to 20 percent polycrystalline quartz. All the quartz grains are fine to coarse grained, and where not in contact with other grains range from angular to subrounded to cuspate in shape. Where adjacent grains are touching, they have sutured grain boundaries due to compaction. Potassic feldspar makes up 0 to 9 percent of the wacke, and plagioclase makes up trace amounts to 4 percent. The plagioclase composition is An_{28-51}. The feldspars occur in subrounded fine to coarse grains, and are weakly to strongly altered. Some grain boundaries are sutured. One sample contains 2 percent lithic fragments. They are medium to coarse grained, subrounded and equant, and consist of fine-grained granitic rock. Minor amounts of detrital biotite and chlorite after biotite are present in one sample. The matrix makes up 37 to 61 percent of the wackes. It consists of silt-sized particles of muscovite, biotite, quartz and feldspar.

Photo 10. Cross-laminated cross-beds with convex-upward reactivation surfaces in the Mississagi Formation. Traverse 39, central Neelon Township.

The compositions of seven samples of arenite are shown on Figure 15. These samples are similar in composition and include subarkose, arkose and sublitharenite. They contain 48 to 75 percent quartz, with sutured grain boundaries. Original polycrystalline grains are difficult to distinguish. It appears, however, that originally monocrystalline quartz made up 17 to 74 percent of these arenites, and polycrystalline quartz made up 0 to 54 percent (Photo 13). Both types of quartz occur in angular to subrounded, equant to oval, medium to coarse grains. From two to six subgrains, with irregular intragrain boundaries, make up the polycrystalline grains. Potassic feldspar makes up 1 to 29 percent of the arenites, and plagioclase makes up less than 1 to 7 percent of the arenites. The plagioclase composition is An_{30-60}. The feldspar grains are equant, subrounded to rounded, fine to coarse grained, and weakly to strongly altered. Lithic fragments make up less than 1 percent of the arenites. They are coarse grained, and consist of siltstone and granitic rock fragments. Fine- to medium-grained muscovite makes up from 1 to 12 percent, and fine-grained biotite makes up from 0 to 6 percent of the arenites. Trace amounts of chlorite after biotite are also present. From 8 to 14 percent matrix is present in the arenites. Rare quartz cement is present in one sample (86RLD-0402).

The litharenite sample is from one of the uppermost beds of the Mississagi Formation, where the contact with the overlying Bruce Formation is gradational. It contains 48 percent quartz, of which 10 percent is monocrystalline quartz occurring in subrounded to rounded, equant to oval medium grains, and 38 percent is polycrystalline quartz, occurring in subrounded to rounded, medium to very coarse grains. Only three percent of potassic feldspar and plagioclase combined are present. The plagioclase composition is An_{34-40}. The feldspars are present as subrounded to rounded, weakly altered medium grains. The matrix makes up 11 percent of the litharenite, and besides silt-sized particles of quartz and feldspar, it consists of biotite and some muscovite. Lithic grains make up 38 percent of the rock. Grains range in size from medium to very coarse sand, to granules and small pebbles. In decreasing order of abundance, they consist of granitic rock, fine-grained diabase and parallel-bedded siltstone.

The remaining two samples for which modal analyses were done, are of brecciated Mississagi Formation, and of material from a sandstone dike crosscutting the formation.

Modal analyses of rocks of the Mississagi Formation are shown in Table 4 of Appendix 2 and whole rock geochemical analyses are shown in Table 5 of Appendix 2.

QUIRKE LAKE GROUP

The Quirke Lake Group is the second of the three tripartite sequences in the Huronian Supergroup in the southern Cobalt Embayment. The Quirke Lake Group consists of conglomerate of the Bruce Formation, argillaceous and calcareous rocks of the Espanola Formation, and arenites of the Serpent Formation. Modal analyses of samples from these formations are listed in Table 6 of Appendix 2. Table 7 of Appendix 2 lists whole rock geochemical analyses for some of these samples.

Photo 11. Coset in the Mississagi Formation with trough cross-beds overlying planar cross-beds. Traverse 39, central Neelon Township.

Bruce Formation

INTRODUCTION

Rocks of the Bruce Formation form a north- to northeast-trending band across northern Dryden and Falconbridge townships, and a parallel band farther east across central Street Township. In northern Street and Scadding townships, the north- to northeast-trending bands merge, and the Bruce Formation underlies a wide area of irregular shape controlled by a series of gently plunging anticlines and synclines. The formation consists of dark grey to grey-brown polymictic paraconglomerate and pebbly wacke, that are dark grey and rusty grey to brown on weathered surfaces, with minor amounts of buff to grey, fine- to medium-grained arenite that is pink to grey on weathered surfaces. The Bruce Formation is thickest in southern Falconbridge and northern Dryden townships. It is at least 1580 m thick in that area. The formation thins rapidly in central Falconbridge Township, and is less than 350 m thick in central Street Township. The thickness of the Bruce Formation in northern Street and Scadding townships cannot be determined because of the presence of thick overburden.

The Bruce Formation overlies the Mississagi Formation with a gradational to disconformable contact. In northern Dryden Township, interlaminated siltstone and arenite, and pebbly wacke are interbedded with the arenite in the uppermost part of the Mississagi Formation. In southern Falconbridge Township, Mississagi Formation arenite and wacke in beds up to 1 m thick are overlain by silty wacke of the Bruce Formation with 1 to 5 percent clear coarse-grained to granular quartz in the matrix, and rare pebbles up to 1 cm across. In some places the silty wacke conformably overlies the arenite, while nearby it is present in channels up to 2.5 m deep in the top of the Mississagi Formation.

PETROGRAPHY

Polymictic paraconglomerate is the most abundant rock type in the Bruce Formation (Photo 14). It contains from 1 to 40 percent clasts, but in most places 5 to 10 percent clasts are present. Most clasts are 2 to 5 cm across, but some clasts up to 10 cm, and rarely up to 100 cm across are present. They consist of quartz, equigranular coarse-grained granite, and less commonly, very fine-grained foliated granite, pyritic gabbro, mafic metavolcanics, fine- and coarse-grained arenite, and rare diorite. Most clasts are oval to elongate in shape, and range from angular to round. The matrix consists of siltstone to silty, medium-grained wacke, with 1 to 20 percent coarse-grained to granular grey quartz, and 1 to 5 percent coarse-grained to granular feldspar. The pebbly wacke in the Bruce Formation is identical to the polymictic paraconglomerate, except that less than 5 percent clasts are present. Most of the conglomerate and pebbly wacke are massive. Exceptions include rare, poorly defined channels and faint cross-beds near the base of the formation, and a section 100 to 200 m from the bottom of the formation where parallel-laminated conglomerate with dropstones is present. Poorly developed cross-beds are also present in this section (Photo 15). Interbedded arenite and massive conglomerate occur in the lower middle part of the formation. Rare parallel-bedded conglomerate with beds 30 to 100 cm thick is present in the upper middle part of the formation, and parallel-bedded conglomerate with silty interbeds is present in the uppermost part of the formation. There is a faint gradation in the abundance of clasts from the bottom to the middle, and the middle to the top of the formation, with the abundance greatest in the middle of the formation. There is no distinct preferred orientation of the clasts in the conglomerate or pebbly wacke, except for a very slight preference for orientation parallel to bedding.

Arenite in the Bruce Formation occurs in tabular beds 50 to 70 cm thick, with conformable to scoured bases. Discontinuous beds of arenite filling channels are also present. Some beds contain parallel laminations 1 to 2 cm apart, planar cross-laminations and lenticular ripple cross-laminations, while other beds appear massive. Some apparently massive beds do, however, show parallel laminations in contact metamorphosed sections

Photo 12. Well-developed trough cross-beds in the Mississagi Formation. Traverse 39, central Neelon Township.

immediately adjacent to Nipissing gabbro bodies. The parallel laminations are graded in places, and some have concentrations of coarse lithic grains and granules at the base. The arenite is present near the base of the formation and in a section near the middle of the formation. In both places it is interbedded with conglomerate and pebbly wacke. Gross 50 to 150 m thick fining-upward sequences are present in the interbedded arkose-conglomerate successions. Each such sequence is topped by massive conglomerate. At the top of the arenite-rich section in the middle of the formation, conglomerate cuts the arenite in channels more than 3 m deep. Discontinuous and tabular beds of arenite and wacke are also present in places at the top of the formation. Some of these beds contain dropstones.

The compositions of five wacke samples are shown on Figure 17. The compositions are varied, and include subarkosic wacke, sublithwacke, lithic arkosic wacke, feldspathic lithwacke and lithwacke. All five form the matrix of pebbly wacke or conglomerate. The wacke is fine to coarse grained. Lithic grains (Photo 16) grade from fine to very coarse grains to granules and small pebbles. The wacke contains 13 to 39 percent quartz, with 10 to 25 percent monocrystalline quartz, and 3 to 24 percent polycrystalline quartz. The monocrystalline quartz is fine to medium grained. The grains are angular to subrounded, and equant to elongate. The polycrystalline quartz is medium to very coarse grained, and also occurs in angular to subrounded, equant to elongate grains. From 0 to 9 percent potassic feldspar, and less than 1 to 2 percent plagioclase are present in the wacke. Where present, the potassic feldspar is very fine to fine grained. The grains are subangular to subrounded, and equant to oval. The plagioclase occurs as equant to oval, subangular to subrounded fine grains. The potassic feldspar and plagioclase are weakly to moderately altered. The composition of the plagioclase is An_{32-58}. Lithic fragments make up 1 to 28 percent of the wacke. Parallel-laminated siltstone fragments are present in four of the five samples, and are the most abundant type of lithic fragment. They occur in subangular elongate grains from very coarse sand to small pebble size. Granitic rock fragments are present in all five of the samples, but are less abundant than the siltstone fragments. The granitic rock fragments are subangular to subrounded, and equant to oval. They occur as very coarse grains to small pebbles. Some contain micrographic intergrowths. A few subrounded, oval, medium to coarse grains of diabase are present in three of the samples. The composition, size, shape and angularity of clasts from three samples of conglomerate are shown on Figures 18a, b and c. The samples come from the lower, middle and upper parts of the formation. The contents of metavolcanic and quartz clasts decrease from the bottom to the top of the formation, while the contents of granite and probable siltstone clasts increase from the bottom to the top. The clasts macroscopically identified as siltstone clasts may be of the same siltstone present as lithic fragments in the thin sections. There is also 0 to 6 percent fine-grained biotite, and 0 to 2 percent fine-grained chlorite in the wacke. The chlorite is secondary after biotite. From 23 to 66 percent matrix is present in the wacke, and one sample contains 10 percent calcite cement in irregular interstitial grains 0.05 to 0.2 mm across.

The compositions of five samples of Bruce Formation arenite are shown on Figure 19. There are three samples of subarkose, one of arkose and one of feldspathic litharenite. The subarkose and arkose are simi-

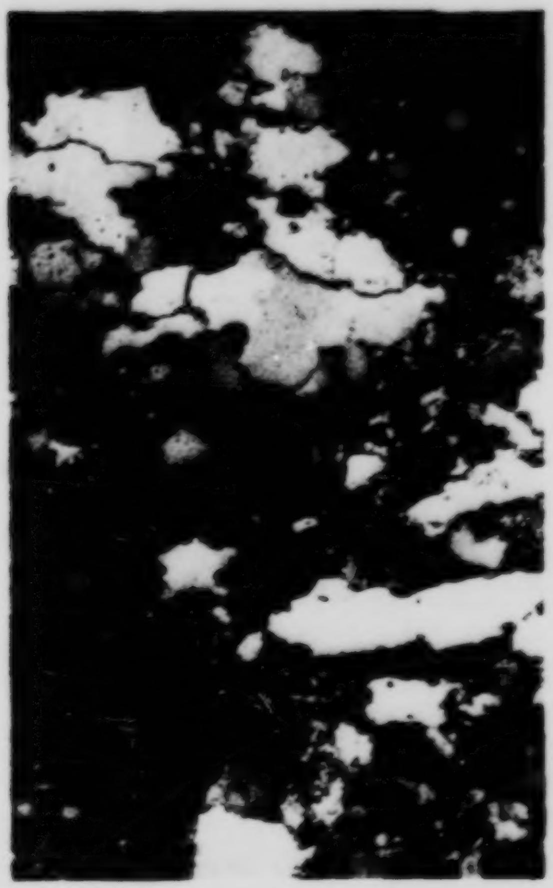


Photo 13. Sutured intergrain boundaries between monocrystalline and polycrystalline quartz grains in Mississagi Formation subarkose. Note micrographic intergrowth in orthoclase at the center of the photo. Crossed polarizers, field of view 2 mm high. Sample 86RLD-0805, Traverse 8, southwestern Falconbridge Township.

lar in composition. They contain 64 to 80 percent quartz. It is difficult to distinguish between monocrystalline quartz and what was originally polycrystalline quartz. Compaction of the arenite has caused sutured boundaries between adjacent grains, and the original outlines of grains have been obscured. The quartz grains are medium to very coarse grained and subrounded. Rare quartz granules are present. Potassic feldspar makes up 0 to 24 percent, and plagioclase makes up 1 to 4 percent. The plagioclase composition is An_{28-55}. The feldspars occur in rounded medium to coarse grains, and are weakly altered. Lithic fragments are present in two of the samples, and make up less than 1 and 9 percent, respectively, of the rock. The most common lithic fragments are micrographic intergrowths of quartz and feldspar. Granitic fragments are less common. Rare fragments of fine-grained diabase are also present. Medium-grained muscovite is present, and makes up less than 1 to 4 percent of the rock. The matrix makes up 3 to 13 percent of the subarkose and arkose. Two samples contain 7 and 24 percent of calcite cement.

The feldspathic litharenite is the matrix of a pebbly arenite. It contains 54 percent quartz, with 3 percent monocrystalline quartz and 51 percent polycrystalline quartz. The monocrystalline quartz is present as subrounded fine to medium grains. The polycrystalline quartz is medium to very coarse grained. There is 7 percent potassic feldspar and 7 percent plagioclase. The feldspars occur in subrounded medium to coarse grains, and are weakly altered. The plagioclase composition is An_{23-51}. Lithic fragments make up 23 percent of the feldspathic litharenite. Although most of the pebbles and cobbles in this pebbly arenite are of granitic rock, the sand-sized lithic fragments consist of 19 percent of parallel-laminated siltstone and only 3 percent of fine-grained granitic rock. There is also 1 percent of lithic grains of intermediate volcanic rock. All are medium to very coarse grained. Biotite makes up 5 percent of the rock. It is pleochroic and occurs as fine grains. There is only 1 percent matrix in the feldspathic litharenite, but 3 percent calcite cement is present.

Photo 14. Bruce Formation massive polymictic paraconglomerate. Traverse 29, south-central Scadding Township.

Photo 15. Poorly defined cross-laminations in Bruce Formation pebbly wacke. Traverse 42, northwestern Dryden Township.

Modal analyses of rocks of the Bruce Formation are presented in Table 6 of Appendix 2 and whole rock geochemical analyses are presented in Table 7 of Appendix 2.

Espanola Formation

INTRODUCTION

Rocks of the Espanola Formation form a thin, northeast-trending band across northern Dryden and Falconbridge townships, and a parallel band across central Street Township. In northern Street and Scadding townships, the formation is present in a series of irregular bands and areas. It consists of grey, pink, white and mottled detrital and calcareous to dolomitic detrital rocks and limestone that are light to dark grey, pink and white on weathered surfaces. The detrital and calcareous to dolomitic detrital rocks include siltstone and fine- to medium-grained arenite and wacke, and calcareous siltstone, arenite and wacke. Exposure of the formation throughout its extent is poor. In central Falconbridge Township the formation is about 250 m thick, but elsewhere the thickness varies, and the formation appears to be missing in places.

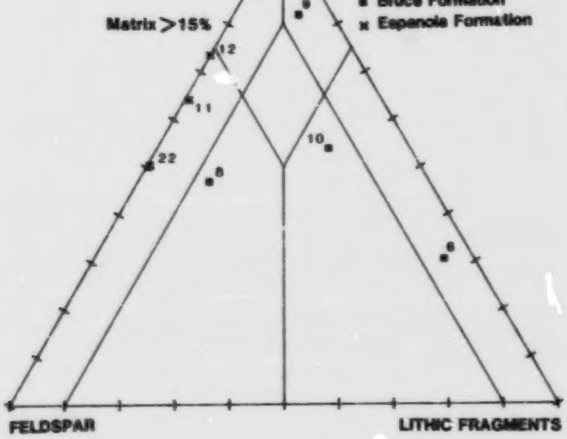


Figure 17. Composition of Quirke Lake Group wackes.

The Espanola Formation overlies the Bruce Formation. The contact between the formations is conformable and gradational over a thickness of up to 3 m. Calcareous siltstone and wacke occur in places as interbeds with pebbly wacke near the top of the Bruce Formation. In other places, pebbly wacke grades upward into massive to parallel-laminated siltstone and calcareous siltstone to wacke, with rare pebbles up to 1 cm across in the lowermost 4.5 m of the Espanola Formation.

PETROGRAPHY

The siltstone to medium-grained wacke in the Espanola Formation is massive to parallel laminated, with beds 1 to 10 cm thick. Near the base of the formation, some 1 cm thick siltstone laminations are graded, and tiny load casts are present at the base of each one. Calcareous and dolomitic siltstone occur as massive beds 5 to 30 cm thick.

Fine- to medium-grained arenite occurs in beds 1 to 30 cm thick, with lenticular bedding in places where the

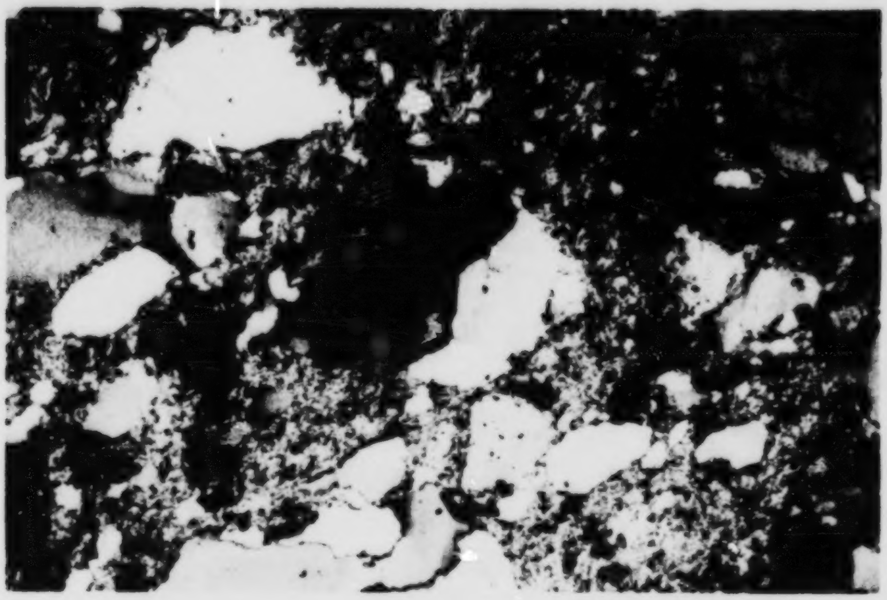


Photo 16. Granitic lithic fragment surrounded by matrix in Bruce Formation wacke. Crossed polarizers, field of view 2 mm across. Sample 86RLD-0906, Traverse 9, south-central Falconbridge Township.

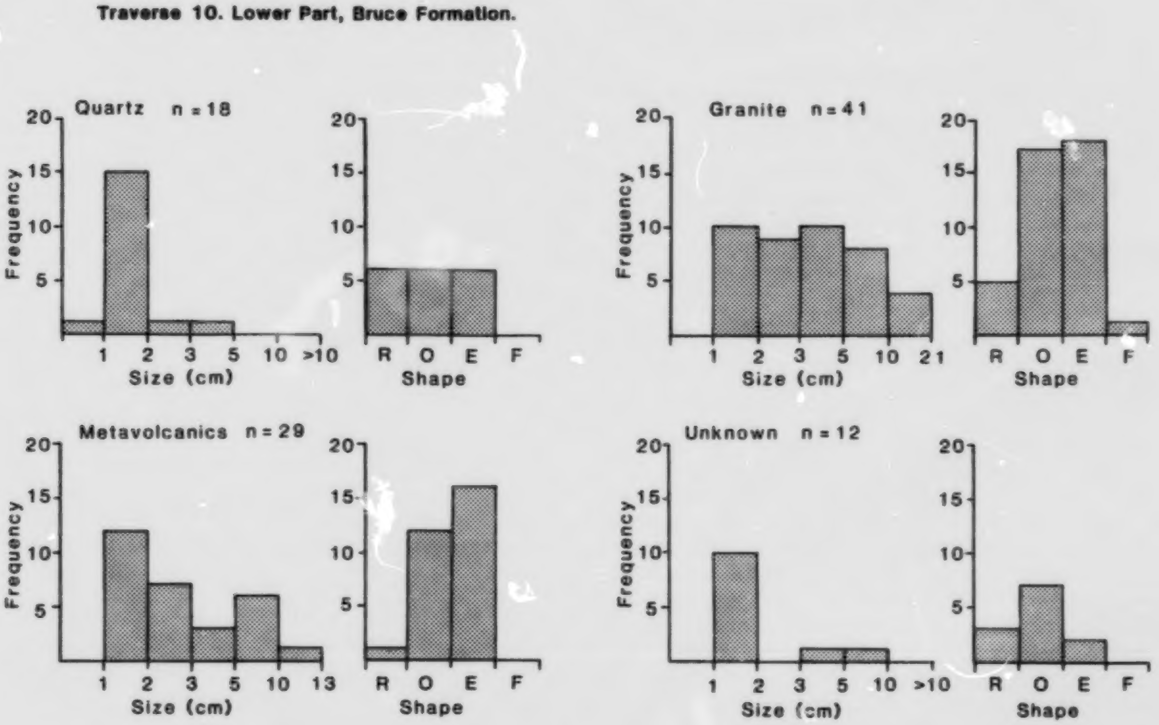


Figure 18a. Composition, size, shape and angularity of pebbles and cobbles in lower Bruce Formation conglomerate.
Shape: R - round, O - oval, E - elongate, F - flat
Angularity: A - angular, SA - subangular, SR - subrounded, R - rounded

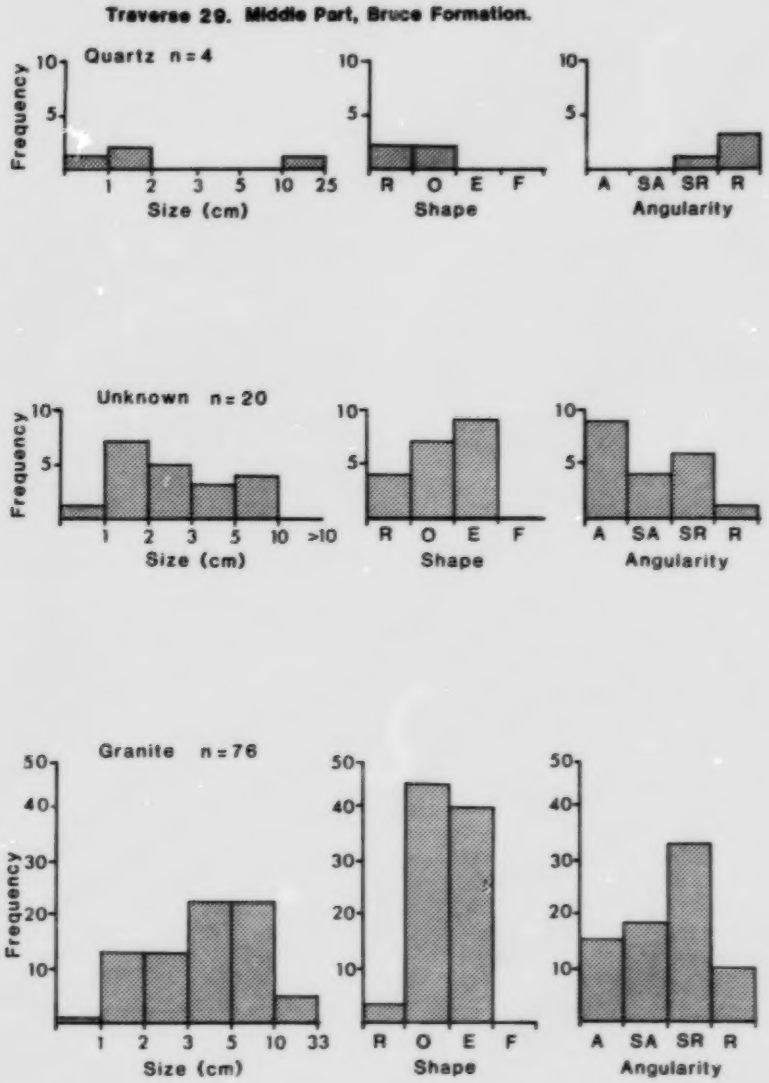


Figure 18b. Composition, size, shape and angularity of pebbles and cobbles in middle Bruce Formation conglomerate.
Shape: R - round, O - oval, E - elongate, F - flat
Angularity: A - angular, SA - subangular, SR - subrounded, R - rounded

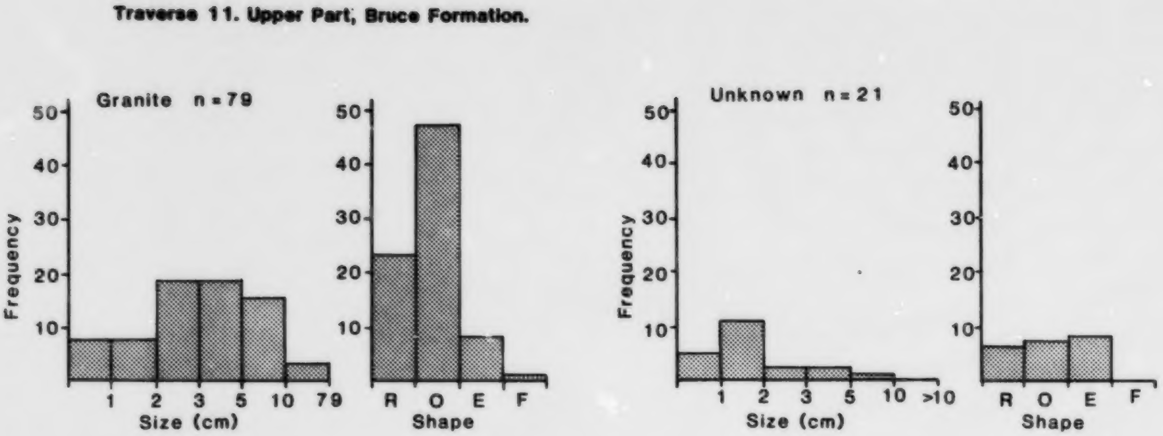


Figure 18c. Composition, size, shape and angularity of pebbles and cobbles in upper Bruce Formation conglomerate.
Shape: R - round, O - oval, E - elongate, F - flat
Angularity: A - angular, SA - subangular, SR - subrounded, R - rounded

beds are 1 to 3 cm thick. Most beds are parallel laminated, but some beds near the top of the formation have ripple cross-laminations and rare mud chips. Angular coarse grey quartz grains similar to grains found in Bruce Formation conglomerate and wacke form up to 2 percent of the arenite near the base of the formation. Calcareous fine-grained arenite occurs as parallel-laminated beds 2 to 10 cm thick.

Limestone in the Espanola Formation is pure and massive to silty and parallel laminated. It occurs in beds 20 to 60 cm thick.

The various rock types are interstratified, often at a bed-by-bed scale. Some beds have variable thicknesses and some beds are discontinuous due to scouring at the base or top of the bed. Some scours are as much as 100 cm deep, and channels as much as 2 m deep and 15 m wide are present.

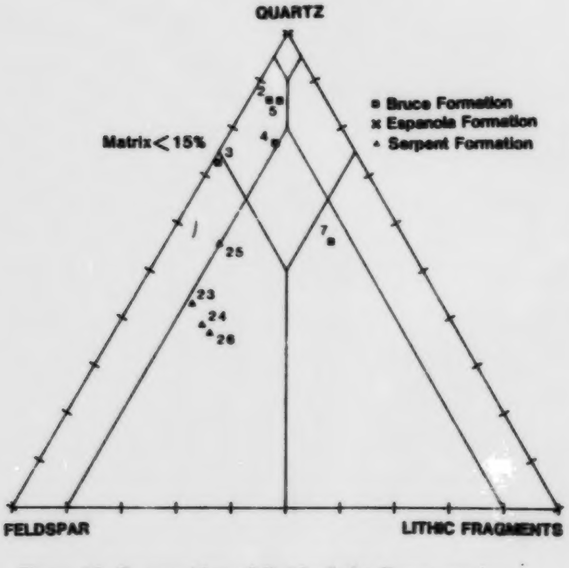


Figure 19. Composition of Quirke Lake Group arenites.

Three poorly defined intergradational members are present in the Espanola Formation. Beds in the lower member are very thin to thin. Detrital material is very fine or fine grained, and the overall carbonate content is approximately 15 percent. In the middle member, bed thicknesses, grain size and carbonate content all increase. Beds are medium to thick, detrital material is fine grained or medium grained, and the overall carbonate content is approximately 40 percent. In the upper member, bed thickness, grain size and carbonate content decrease. Beds are very thin to thin, detrital material is very fine grained, and the overall carbonate content is less than 10 percent.

The modal analyses of two samples of siltstone and one sample of metasiltstone are listed in Table 6 of Appendix 2. The siltstone is parallel laminated, with laminations 2 to 20 mm thick which grade from siltstone at the base to argillite at the top. Very faint, discontinuous parallel laminations approximately 0.2 mm apart are present in some places. Bed contacts are sharp. In places the parallel laminations are distorted, while elsewhere, tiny dewatering channels less than 5 mm across cut through several laminations. Some very angular to subangular, very fine to fine grains of quartz, feldspar, biotite and rare secondary chlorite after biotite are present. Rare fine-grained lithic fragments of gabbro, siltstone and quartz-feldspar porphyry are also present. Minor amounts of calcite occur as a replacement mineral in the matrix, and in thin veinlets. The metasiltstone contains 34 percent scapolite (Photo 17). The scapolite is present in equant poikiloblastic grains up to 1 mm across. Some grains are intergrown, and some are twinned with up to three twin surfaces meeting at 120°. Some grains are partly or completely altered to fibrous chlorite. The sca-

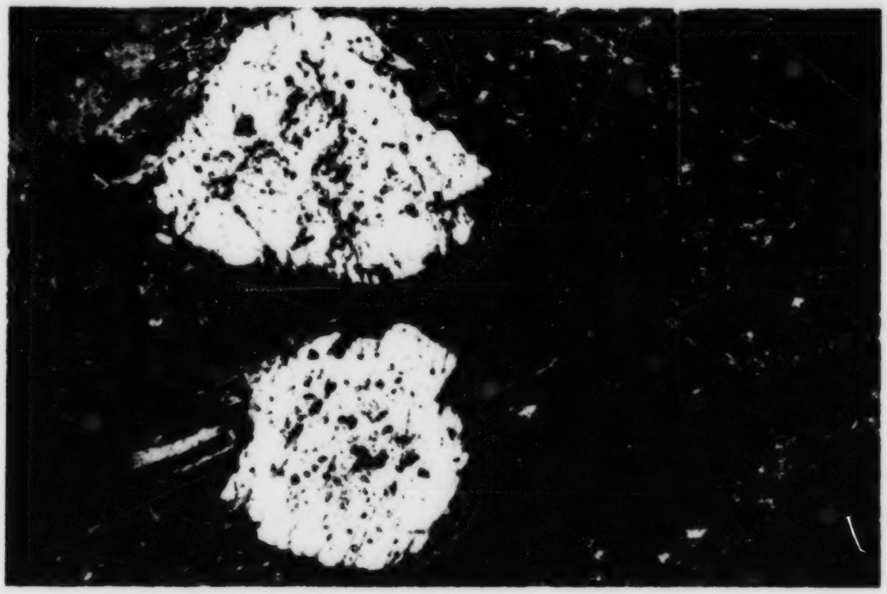


Photo 17. Scapolite porphyroblasts in Espanola Formation metasiltstone. Crossed polarizers, field of view 2 mm across. Sample 86RLD-4403, Traverse 44, north-central Dryden Township.

polite is most abundant in the more argillaceous layers of the siltstone.

The compositions of three samples of wacke are shown on Figure 17. All are of very fine to fine-grained arkosic wacke. The quartz content of the wacke ranges from 34 to 54 percent, with 31 to 34 percent monocrystalline quartz and 0 to 22 percent polycrystalline quartz. It is difficult to distinguish between monocrystalline and polycrystalline quartz in the wacke, as grain boundaries in all the samples have been sutured due to compaction. The monocrystalline quartz is very fine to fine grained, subangular to subrounded, and oval. The polycrystalline quartz is medium grained, subrounded and oval. These rocks contain 3 to 29 percent potassic feldspar and 6 to 10 percent plagioclase. The feldspars occur in subrounded to rounded, oval fine grains with weak to strong alteration. The composition of the plagioclase is An_{35-50}. The wackes contain 15 to 39 percent matrix, made up of silt-sized particles of quartz, feldspar and mica. One sample contains 15 percent calcite cement, which is present in pale green silt-sized grains.

The modal analyses of three samples of silty limestone and dolostone are listed in Table 6 of Appendix 2. They are poorly laminated, with laminations up to 1 mm thick. The laminations are defined by variations in the relative abundance of carbonate minerals and matrix. The carbonate minerals are very fine to fine grained, and have irregular grain boundaries. In one sample, rounded grains of inclusion-free carbonate are enclosed by grains of inclusion-filled carbonate. The texture may be metamorphic, as phlogopite is present in the sample. Trace amounts of very fine-grained muscovite and chlorite are present in one sample, and 7 percent of very fine-grained phlogopite is present in another. The matrix consists of silt-sized particles of quartz and feldspar.

The modal analyses of three samples of contact metamorphosed calcareous sedimentary rocks are also listed in Table 6 of Appendix 2. All three samples are from locations near the contact of a large Nipissing gabbro body. One may have been brecciated prior to metamorphism. All contain poikiloblastic irregular to rare euhedral grains of hornblende and chlorite. In places, the hornblende is replaced in part by chlorite microlites, which in turn are replaced by calcite. Calcite veinlets are also present.

Whole rock geochemical analyses of the Espanola Formation are presented in Table 7 of Appendix 2.

Serpent Formation

INTRODUCTION

Rocks of the Serpent Formation form a "V"-shaped band marking the limbs of a northeast-plunging syncline across Dryden, Falconbridge and Street townships. That area of outcrop is truncated by a fault across its northern limit, but the formation is exposed again farther north in central Scadding Township in a series of southeast-trending bands. The formation consists of light to dark grey, pink, cream and buff, fine- to medium-grained arenite and fine-grained wacke that weather light to dark grey, pink, buff and tan in colour. In Street Township, an incomplete section of the Serpent Formation is about 670 m thick. In Scadding Township, a complete section is 350 m thick. This thinning may be due to the Serpent Formation, like the underlying units, thinning northward, or it may be due to differential erosion prior to deposition of the Gowganda Formation.

The Serpent Formation overlies the Espanola Formation throughout most of its extent, but it overlies the Bruce Formation in the few areas where the Espanola Formation is missing. The contact with the Espanola Formation is gradational. It is difficult to place the contact exactly, as the transition is so gradual, but it is assigned to the horizon where calcite disappears from the wacke interbeds. The uppermost part of the Espanola Formation then consists of parallel-laminated to ripple cross-laminated fine-grained arenite in beds up to 15 cm thick and calcareous fine-grained wacke in beds up to 50 cm thick. Above this, fine-grained arkose in beds 5 to 30 cm thick is interbedded with parallel-laminated fine-grained noncalcareous wacke in beds 2 to 10 cm thick. The contact with the Bruce Formation is sharp and conformable. The uppermost Bruce Formation consists of massive pebbly wacke with most clasts smaller than 2 cm in diameter. Right at the top of the formation, massive polymictic paraconglomerate with 10 percent clasts up to 20 cm across is present. The conglomerate is overlain by parallel-laminated, medium- to coarse-grained arenite in beds 20 to 75 cm thick. Rare pebbles up to 5 cm across are present in the lowermost 7 m of the arenite. This arenite grades upward to massive fine- to medium-grained arenite.

PETROGRAPHY

Arenite in the Serpent Formation contains few depositional features. Most beds are massive, and bed contacts are gradational and very indistinct. Some parallel laminations (Photo 18), planar cross-laminations with shallow to very shallow foresets, and rare trough cross-beds are present. The lower part of the formation consists of massive to faintly parallel-laminated, fine-grained arenite in beds 30 to 80 cm thick. Planar cross-laminations, in places scouring underlying beds, are rarely present. Siltstone and fine-grained wacke occur as minor interbeds. The middle and upper parts of the Serpent Formation consist of fine- to medium-grained arenite in beds 20 to 40 cm, and rarely up to 150 cm thick. Most beds are massive, and cross-laminations are rare.

The compositions of four samples of Serpent Formation arenite are indicated on Figure 18. All four of the samples are of lithic arkose (Photo 19). They contain 32 to 55 percent quartz, with 25 to 43 percent monocrystalline quartz and less than 1 to 12 percent polycrystalline quartz. Both types of quartz occur as subrounded to rounded, equant to oval fine grains. Potassic feldspar makes up 21 to 37 percent of the lithic arkose. Plagioclase makes up 3 to 10 percent. The feldspars occur as subrounded to rounded, equant to oval fine grains, and are weakly altered. The plagioclase composition is An_{33-59}. Lithic fragments are absent in one sample. In the other three, they make up 3 to 8 percent of the rock. They are fine grained, and consist of fragments of fine-grained arenite and granitic rock. Very fine-grained detrital mica makes up 2 to 15 percent of the lithic arkose. Muscovite contents range from 0 to 2 percent. Biotite contents range from 0 to 15 percent, and chlorite contents range from less than 1 to 4 percent. The chlorite is secondary after biotite. Two samples contain small amounts of very fine grains of interstitial dolomite. One sample from near the top of the formation, which megascopically looks no different from the others, contains

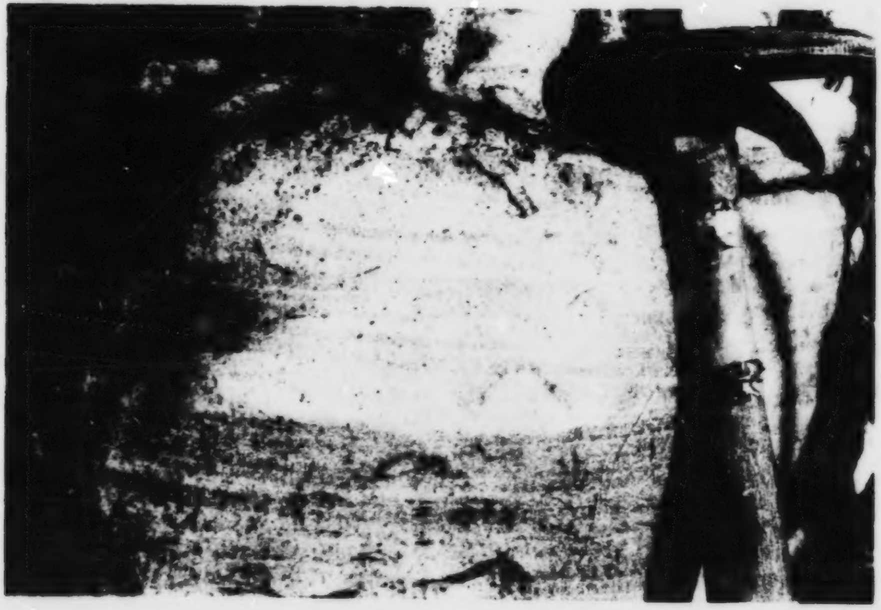


Photo 18. Parallel laminations in medium-grained arenite of the Serpent Formation. Traverse 35, central Street Township.

Photo 19. Fine-grained lithic arkose with weakly altered feldspars, Serpent Formation. Crossed polarizers, field of view 2 mm across. Sample 86RLD-3001, Traverse 30, south-central Scadding Township.

almost 5 percent of very fine grains of accessory minerals. Zircon is most abundant, and occurs as rounded to subrounded grains with cloudy surfaces. Titanite is less common, and is present as subangular grains. Angular grains of corundum are also present.

Modal analyses of rocks of the Serpent Formation are presented in Table 6 of Appendix 2 and whole rock geochemical analyses are presented in Table 7 of Appendix 2.

COBALT GROUP

The Cobalt Group is the uppermost of the three tripartite sequences in the Huronian Supergroup in the southern Cobalt Embayment. The sequence of conglomerate—argillaceous rock—arenite is not as well developed in the Cobalt Group as in the Hough Lake and Quirke Lake groups, but consists of conglomerate and parallel-laminated argillite to siltstone of the Gowganda Formation, and arkose of the Lorrain Formation. Modal analyses of samples from these formations are listed on Table 8 of Appendix 2. Table 9 of Appendix 2 lists whole rock geochemical analyses for samples from the Cobalt Group.

Gowganda Formation

INTRODUCTION

Rocks of the Gowganda Formation form a broad north- to northeast-trending band across parts of Dryden, Falconbridge and Street townships. The band forms the core of a northeast-plunging syncline, which is truncated by a fault in northern Street Township. Rocks of the Gowganda Formation are also present in the northeast half of Scadding Township and in much of Rathbun Township. The Gowganda Formation consists of dark grey to dark green, massive to parallel-laminated, argillite to siltstone, sparsely pebbled argillite to siltstone, massive to parallel-bedded polymictic paraconglomerate to pebbly wacke that weather dark grey, dark green and cream in colour; and light grey to buff, thinly to medium-bedded, fine- to medium-grained wacke and minor arenite that weather pale grey to cream in colour. Argillite to siltstone and sparsely pebbled argillite to siltstone is the predominant rock type. No complete section of the Gowganda Formation is present in the area studied due to erosion and disruption of the section by faulting. The thickest section measured is 900 m thick.

The Gowganda Formation unconformably overlies the Serpent Formation. Where the contact is exposed in Scadding Township, cobbles of Serpent Formation arenite are present in conglomerate in the lowermost few metres of the Gowganda Formation (Photo 20). Stereographic manipulation of bedding attitudes recorded at the contact further indicate that rocks of the Serpent Formation had been folded into open folds to form a gently dipping surface prior to deposition of the Gowganda Formation.

PETROGRAPHY

The mudstone to siltstone in the Gowganda Formation is dark grey to dark green weathering at the base, and grades upward to pale grey to cream weathering at the top of the formation. It is massive to parallel laminated, with laminations 1 to 3 mm thick. A few of the coarser siltstone horizons are very thinly bedded, with beds 1 to

Photo 20. Lowermost Gowganda Formation conglomerate in foreground, with arenite clast above hammer, unconformably overlies Serpent Formation arenite in background. Traverse 31, south-central Scadding Township.

3 cm thick, and have rare ripples with amplitudes up to 2 cm. Granules and pebbles, usually less than 3 cm across but rarely up to 50 cm across, are present in places. Some are obviously dropstones. Near the base of the formation, a unit of strongly plastically deformed parallel-laminated mudstone is present between undeformed mudstone units. Elsewhere, rare dark grey cherty mudstone is present.

The mudstone to siltstone in the Gowganda Formation grade through sparsely granular and sparsely pebbled siltstone to granular siltstone and very fine-grained pebbly wacke. The granular siltstone and very fine-grained pebbly wacke occur as massive to parallel-laminated beds, with rare load casts at the base of some parallel-laminated beds. They contain up to 5 percent clasts, mostly of granule and small to medium pebble size, in a dark grey siltstone to very fine-grained wacke matrix. The clasts consist of granite, mafic metavolcanic rocks, arenite, metasedimentary rocks including rare black chert, and gabbro. Quartz clasts are rare. The clasts are angular to rounded, and round to elongate. The gritty siltstone and very fine-grained pebbly wacke are most common near the top of the formation.

Conglomerate present in the Gowganda Formation has 5 to 10 percent clasts in a dark grey fine- to medium-grained wacke matrix. The matrix contains up to 5 percent coarse-grained quartz in places. Most clasts are 2 to 15 cm across, but some are up to 50 cm across. The smaller clasts are granitic, mafic metavolcanic and metasedimentary rocks, and gabbro. Most of the larger clasts are granitic. No preferred orientation of clasts is present in parallel-bedded conglomerate at the base of the formation (Photo 21), but farther up in the formation, clasts in a 4.5 m thick conglomerate unit with gross stratification defined by differences in the abundance and size of clasts, have a strong preferred orientation parallel to bedding.

Arenite is present near the base and top of the Gowganda Formation. It is present in tabular beds, and fills shallow channels 5 to 100 cm deep. Rare beds of arenite are also present approximately 750 m above the base of the formation. A 20 cm thick arenite bed near the base of the formation is scoured at the base and contains dropstones. Arenite within, and near the top of the formation is massive to parallel laminated, with some beds massive at the base and parallel laminated at the top. Rare ripple and trough cross-beds with amplitudes of up to 5 cm are present in the arkose, and in places there are load casts at the bases of arenite beds overlying siltstone. Dropstones are present in some beds.

The siltstone and some of the arenite and wacke of the Gowganda Formation are weakly to strongly magnetic. The magnetite may have been derived from the mafic metavolcanic rocks which supplied detritus to the formation. It may also have been derived from magnetite-bearing granite, such as was found as clasts containing magnetite grains up to 5 mm across in Gowganda Formation conglomerate.

The modal analyses of five argillaceous siltstones are listed in Table 8 of Appendix 2. The siltstones are massive to parallel-laminated, with laminations 0.1 to 5 mm thick. The laminations are poorly graded in places (Photo 22). In other places, isolated individual sand grains lie at intervals along the bedding surfaces in parallel-laminated argillite. In one sample, tiny starved ripples form flasers of silt 3 mm high and 5 mm long in cherty argillite. Some of the ripples are slumped into the underlying beds. In the same sample, tiny load casts 1 mm deep and 2 mm across are present at the base of some 0.3 mm thick laminations. Up to 13 percent sand is present in the siltstone. This includes 0 to 7 percent of angular very fine to coarse grains of monocrystalline quartz, and 0 to 6 percent of similar grains of polycrystalline quartz. Potassic feldspar plus plagioclase make up 0 to 5 percent of the argillaceous siltstone. The feldspars occur as subrounded very fine to medium-sized grains, and are weakly altered. Subrounded to rounded very fine to coarse-grained lithic fragments make up 0 to 4 percent of the siltstone. Granitic lithic fragments are most common, but fragments of fine-grained arenite,

Photo 21. Parallel bedding in polymictic paraconglomerate near the base of the Gowganda Formation. Traverse 31, south-central Scadding Township.

gabbro and porphyritic mafic metavolcanic rock also occur. Rare pebbles up to 25 mm across are also present. The matrix is brownish, and argillaceous to silty.

The compositions of three samples of wacke are shown on Figure 20; one is of subarkosic wacke, and two are of lithwacke. The subarkosic wacke is from a wacke interbed in sandstone. It contains 64 percent quartz, with 60 percent monocrystalline quartz and 4 percent polycrystalline quartz. The monocrystalline quartz is present in angular, irregular fine grains, and subrounded to rounded, equant to oval medium grains. The polycrystalline quartz is present in subangular medium grains. Intragrain boundaries in the polycrystalline quartz are interlocking. The subarkosic wacke contains 13 percent potassic feldspar and 4 percent plagioclase. All are present in subangular to subrounded, equant to irregular, fine- and medium-sized grains, and all are weakly altered. Lithic fragments consisting of subrounded medium grains of quartzofeldspathic micrographic intergrowths make up 3 percent of the rock. The matrix consists of quartz, feldspar and chlorite silt, and makes up 15 percent of the subarkosic wacke.

The lithwacke samples are from the matrix of conglomerates. Both contain small amounts of quartz and feldspar in angular fine to coarse grains. One sample contains 12 percent lithic fragments, and the other contains 78 percent. The lithic fragments grade in size from medium to very coarse sand, granules and pebbles. The smaller grains are angular, and the larger ones are subrounded to rounded. They include chlorite schist, fine-grained diabase, pyroxene andesite, coarse-grained biotite granite, coarse-grained biotite granodiorite and calcareous siltstone. The composition, size, shape and angularity of clasts from two samples of Gowganda Formation conglomerate are shown on Figures 21a and 21b. The samples come from the lowermost bed of the formation and from a bed approximately 500 m above the base. Clasts of arenite and wacke (listed as sediments) are much more common near the base of the formation. This reflects the probable derivation of these clasts from the underlying Serpent Formation. It is notable that quartz granules and pebbles, which are common in the conglomerates of the Ramsay Lake and Bruce formations, are missing from the Gowganda Formation conglomerate.

The composition of one sample of arkose is shown on Figure 22. It contains 42 percent quartz, with 40 percent monocrystalline quartz, and 2 percent polycrystalline quartz having just 2 or 3 subgrains. Both occur in subangular to subrounded, equant to oval fine grains. Thirty-six percent potassic feldspar, and 4 percent plagioclase are also present. The feldspars occur in subangular to subrounded, equant to oval fine grains, and are weakly to strongly altered. A few subrounded to rounded fine-grained lithic fragments consisting of very fine-grained granitic rock are also present. The matrix makes up 11 percent of the arkose, and consists of quartz and feldspar silt.

Modal analyses of rocks of the Gowganda Formation are shown in Table 8 of Appendix 2 and whole rock geochemical analyses are shown in Table 9 of Appendix 2.

Photo 22. Parallel laminations in Gowganda Formation argillaceous siltstone with poorly developed graded bedding in some laminations. Plane light, field of view 2 mm high. Sample 86RLD-4608, Traverse 46, south-central Scadding Township.

Lorrain Formation

INTRODUCTION

Rocks of the Lorrain Formation are present in a small area surrounding Bassfin Lake in southern Rathbun Township, and in a north-trending band extending north from Kukagami Lake in eastern Rathbun Township. They are pink, grey, cream and green weathering, and pink, grey and green on fresh surfaces, and consist of medium- to coarse-grained arenite. There is no complete section of the Lorrain Formation in the area, due to erosion. An incomplete section in Rathbun Township across part of the formation is 330 m thick.

The Lorrain Formation conformably overlies the Gowganda Formation. The contact appears to be gradational over a few metres.

The preserved section of the Lorrain Formation can be subdivided into four intergradational members. These members are roughly correlative with the lower four of six members identified in the formation in the Sudbury–Espanola area (Card et al. 1977). Depositional features are poorly developed and poorly preserved in much of the Lorrain Formation. Where present, many are highlighted by grain size gradations, or by concentrations of hematite.

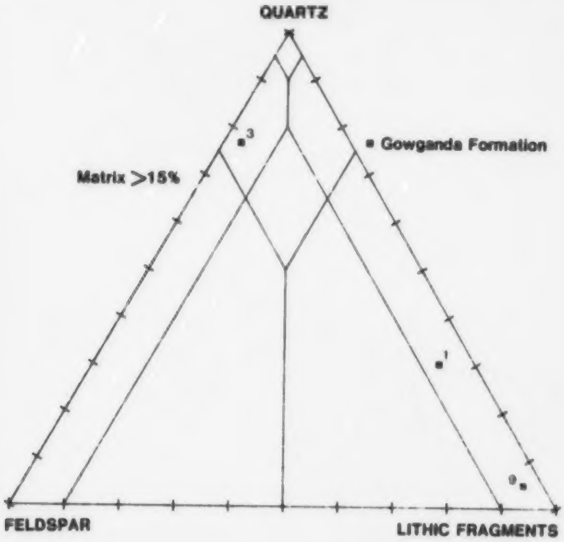


Figure 20. Composition of Cobalt Group wackes.

The lowermost member is the pink and grey sandstone member (Photo 23). This member is at least 15 to 20 m thick, and may be up to 50 m thick. It consists of parallel-laminated, pink feldspathic arenite and grey, silty arenite, with parallel laminations 1 cm apart. Shallow trough cross-beds are present near the base of the section.

The second member is the feldspathic sandstone member. It is 135 to 140 m thick, and consists of pink, medium- and rarely coarse-grained feldspathic arenite. All but the upper 30 m of this member are pink weathering due to red oxidation blebs surrounding detrital hematite grains. The arenite in the upper 30 m of the member does not contain detrital hematite, and is cream weathering. Beds are tabular, and 10 to 30 cm thick. They are massive to cross-bedded. Concentrations of dark detrital minerals including hematite mark the poorly defined foresets and toesets of some low angle cross-beds in the lower part of the member. Some beds grade upward from coarse grained to fine grained, and some foresets in cross-bedded units in the upper 30 m of the member show the same grading. The graded foresets are approximately 5 cm thick.

The third member is the pink and green micaceous sandstone member. It is 35 to 40 m thick, and consists of pink weathering, pink feldspathic fine- to coarse-grained arenite with green weathering micaceous interbeds. The arenite in this member is massive, and bedding cannot be distinguished. The micaceous interbeds

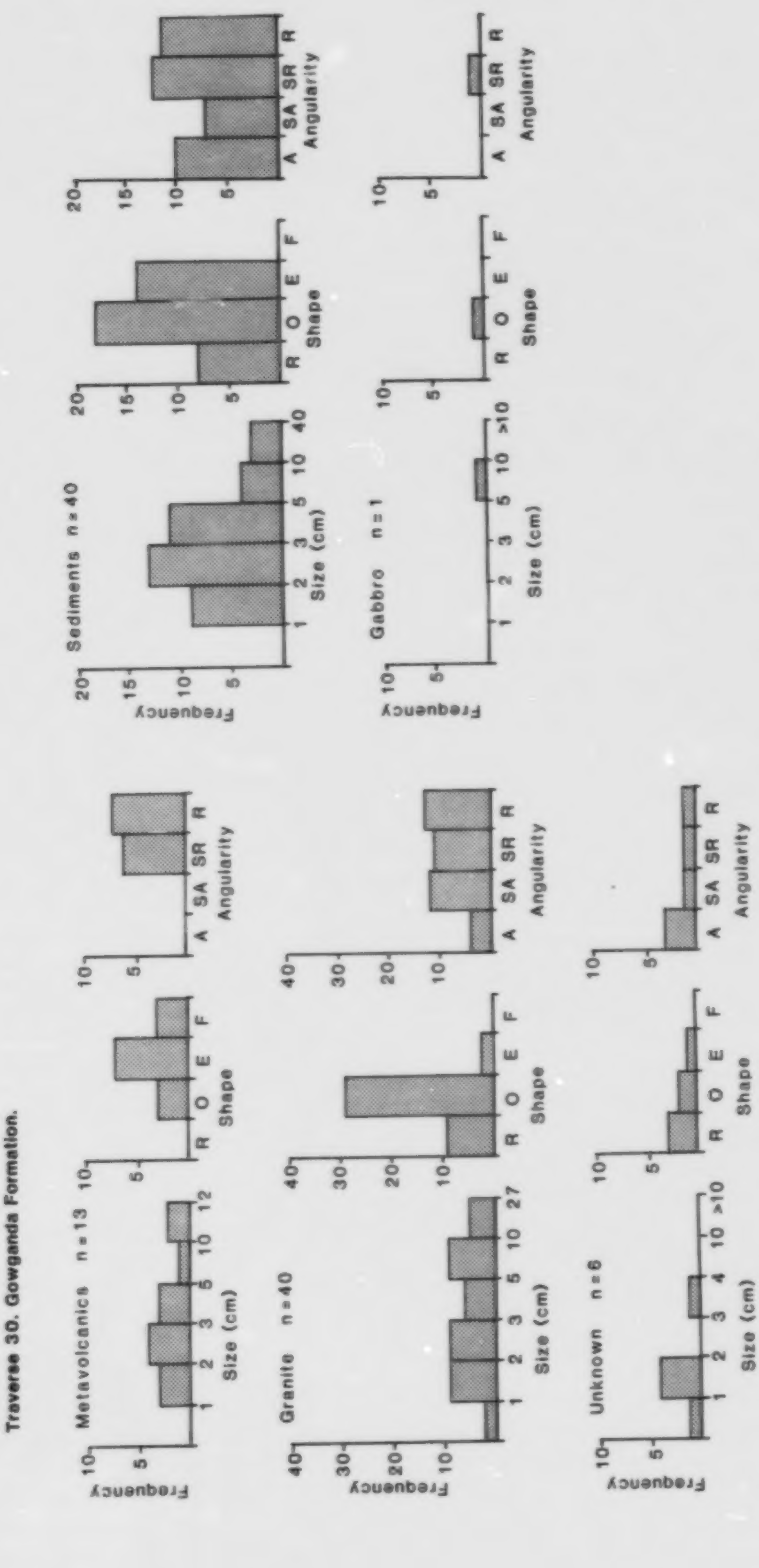


Figure 21a. Composition, size, shape and angularity of pebbles and cobbles in lowermost Gowganda Formation conglomerate.
Shape: R - round, O - oval, E - elongate, F - flat
Angularity: A - angular, SA - subangular, SR - subrounded, R - rounded

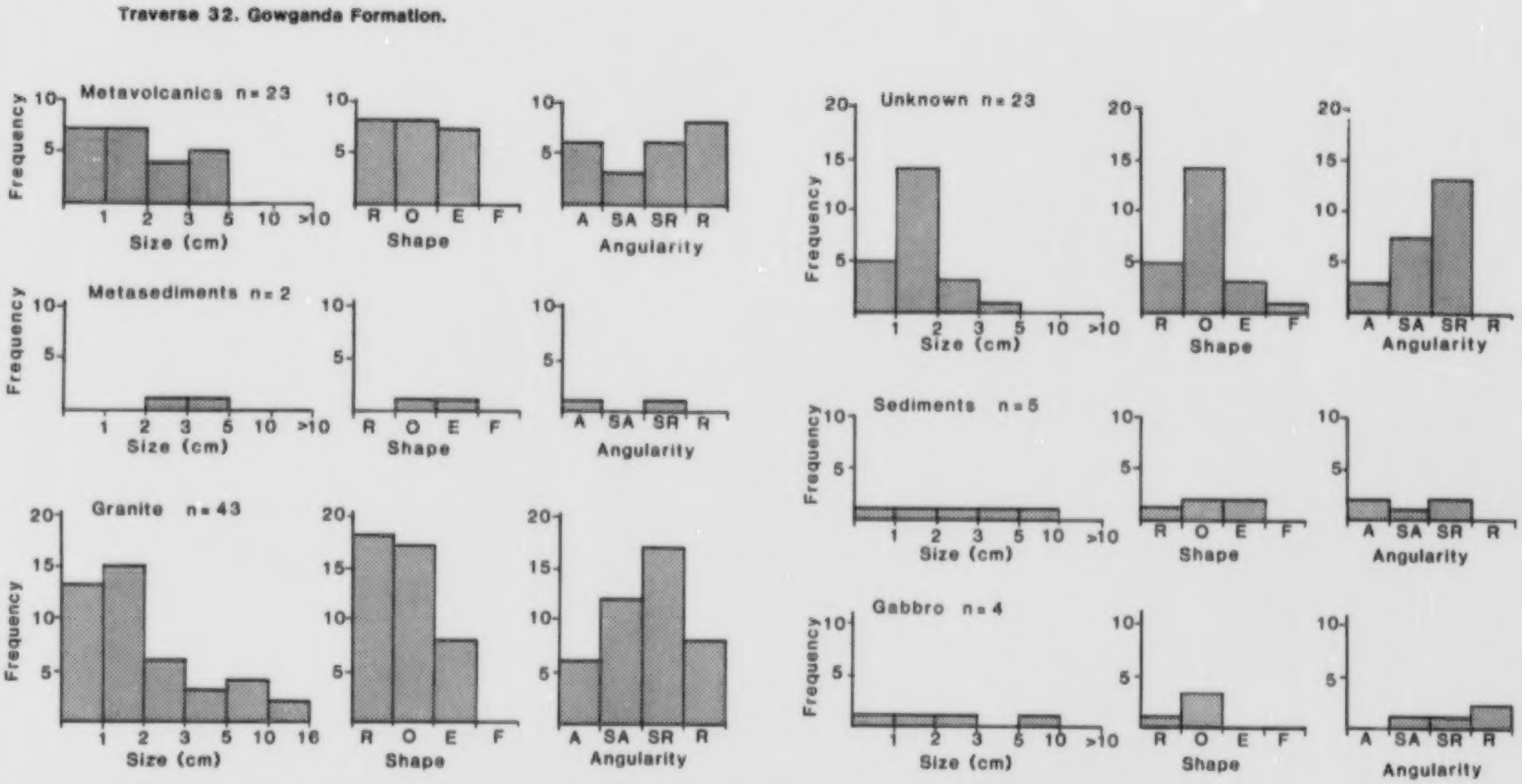


Figure 21b. Composition, size, shape and angularity of pebbles and cobbles in Gowganda Formation conglomerate.
Shape: R - round, O - oval, E - elongate, F - flat
Angularity: A - angular, SA - subangular, SR - subrounded, R - rounded

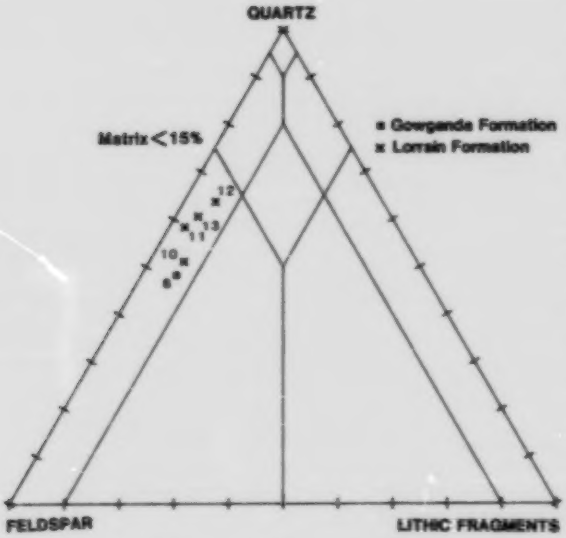


Figure 22. Composition of Cobalt Group arenites.

are 50 to 100 cm thick, and have planar cross-beds with foresets 1 to 2 cm thick. A few of the foresets are graded.

The uppermost member is a hematitic sandstone member. The preserved thickness of this member is approximately 115 m. It consists of cream weathering, fine- to very coarse grained arenite and minor pebbly arenite. Red speckles resulting from the oxidation of hematite are present in places on weathered surfaces. The quartz content increases upward in this member, but the composition remains feldspathic throughout. Stratification is poorly developed, and bedding cannot be distinguished in most places. A few planar cross-beds are present. In some places they have different grain sizes in successive foresets, and in other places they have graded foresets. Rare green micaceous interbeds like those in the underlying member occur in the lower 15 m of this member. Between 65 and 75 m above the base of the member, pebbly arenite with angular to well-rounded white quartz pebbles up to 1 cm across in fine- to coarse-grained arenite is present. The pebbly arenite forms tabular beds approximately 15 cm thick. Some of the beds grade upward from very coarse grained at the base to medium grained at the top.

PETROGRAPHY

The modal compositions of five samples from the Lorrain Formation are listed in Table 8 of Appendix 2. Four samples are of arenite, the fifth is of brecciated arenite. The compositions of the four samples of arenite are shown in Figure 22. All four are arkose. Three of the samples are well sorted, with one fine grained, one medium grained (Photo 24) and one coarse to very coarse grained. The fourth sample is poorly sorted, and fine to coarse grained. The arkose consists of 47 to 63 percent quartz, with 42 to 54 percent monocrystalline quartz and 2 to 14 percent polycrystalline quartz. The monocrystalline quartz occurs in subangular to subrounded, equant to oval grains, except in the poorly sorted arkose where grains are angular to subrounded. The polycrystalline quartz occurs in subrounded to subangular grains, except in the poorly sorted arkose where grains are angu-

Photo 23. Pink and grey banding in arenite from the lowermost member of the Lorrain Formation. Some red speckles surrounding hematite grains show as dark spots at the right side of the photograph. Traverse 45, south-central Rathbun Township.

Photo 24. Lorrain Formation arkose with angular to subrounded grains separated by sericitic matrix. Crossed polarizers, field of view 2 mm across. Sample 86RLD-5804, Traverse 58, eastern Rathbun Township.

lar to subrounded. The grains are made up of two to five subgrains, with irregular intragrain boundaries. Potassic feldspar makes up 26 to 36 percent of the arkose, and plagioclase makes up 2 to 4 percent. The feldspars occur in subangular to subrounded, equant to oval grains, and are weakly to moderately altered. The plagioclase composition is An_{29-43}. The arkose contains 1 to 5 percent lithic fragments. They are present as subangular to subrounded, equant to oval grains, and consist of very fine-grained arenite, granitic, felsic volcanic and micaceous siltstone fragments. The well-sorted arkose samples contain less than 1 to 2 percent matrix, and the poorly sorted arkose contains 8 percent matrix. All of the well-sorted arkose samples contain faint quartz cement. Where best developed, the quartz cement makes up 3 percent of the rock, and consists of clear to inclusion-filled isocrystalline overgrowths on quartz grains.

Two whole rock geochemical analyses of arkoses of the Lorrain Formation are shown in Table 9 of Appendix 2.

NIPISSING INTRUSIVE ROCKS

PETROGRAPHY

Two samples of Nipissing intrusive rocks were modally analyzed. They were examined because of their unusual texture and composition. The modal analyses are listed in Table 10 of Appendix 2. One sample is of granophyre, and the other is of medium-grained adamellite. The granophyre consists of 40 percent micrographic intergrowths, 23 percent potassic feldspar and 26 percent plagioclase. The micrographic intergrowths commonly enclose phenocrysts of potassic feldspar, and are very weakly altered. Potassic feldspar is present in euhedral phenocrysts 10 to 20 mm across, and is weakly to strongly altered. Plagioclase is present in subhedral to euhedral phenocrysts 5 to 10 mm across, and is weakly altered. Small amounts of chlorite, muscovite and calcite are present as alteration minerals in the granophyre.

The adamellite consists of 50 percent quartz, 20 percent potassic feldspar and 28 percent plagioclase. The quartz is present in clear, irregular grains without inclusions. The feldspars are present in anhedral to euhedral grains. Both the potassic feldspar and the plagioclase are weakly altered. The plagioclase composition is An_{30-50}. Minor amounts of muscovite and matrix, now altered to sericite, are present.

A whole rock geochemical analysis of the adamellite is shown in Table 11 of Appendix 2.

Mineral Exploration

The history of mineral exploration and development in the southern Cobalt Embayment area dates back to 1883, when a copper-nickel occurrence associated with the Sudbury Igneous Complex was discovered. Early work in the area concentrated on such deposits. The target of exploration activity shifted during the 1930s to gold occurrences hosted by rocks of the Huronian Supergroup. All the occurrences were, however, vein deposits. Many of them were associated with Nipissing gabbro intrusions (Mossman and Harron 1983, 1984; Dressler 1982). Underground development was done on a number of them. The target of exploration shifted again during the late 1950s, when paleoplacer concentrations of uranium were recognized at the base of the Huronian succession (Thomson 1960, 1961; Meyn 1979; Meyn and Matthews 1980). More recently, exploration for paleoplacer concentrations of gold at the base of the Huronian succession, as well as at specific intervals within the sequence, have been carried out (Long 1981; Long and Colvine 1985; Long and Lloyd 1983; Sauerbrei and Phipps 1983).

Economic Geology

Mossman and Harron (1983) studied data concerning 121 gold and gold-uranium occurrences in the area northeast of Sudbury. They found 11 were in, or adjacent to, diabase dikes, 85 were quartz or quartz-carbonate veins, and 25 were stratiform. The stratiform occurrences all lie to the northwest of the present study area, and are almost all in basal conglomerates in what is called the Mississagi Formation. Mossman and Harron (1984) report studies of 31 gold or gold-uranium occurrences in the Huronian Supergroup. They found 6 in the Elliot Lake Group, 19 in the Hough Lake Group, 4 in the Quirke Lake Group and 2 in the Cobalt Group. They note, however, that 17 of the occurrences are in rocks mapped as being part of the Mississagi Formation, but that may not be correlative with the classical Mississagi Formation of the Hough Lake Group. Wood (1980) reports that the lowermost part of the Mississagi Formation northwest, north and northeast of Lake Wanapitei is distinctly different from the upper parts of the formation. Long (1986) also notes that the highest concentrations of gold in the basal portion of the Huronian Supergroup in the Cobalt Embayment are in what is called the Mississagi Formation, but may be equivalent in part, with strata of the Elliot Lake Group to the south and west of the Cobalt Embayment. The distribution of occurrences is thus biased by labelling lowermost Huronian Supergroup rocks in the Cobalt Embayment as part of the Mississagi Formation. Therefore, of Mossman and Harron's (1984) 31 occurrences, 23 are more accurately from strata in the Elliot Lake Group. Similar strata seen in this study are clearly separated from the Mississagi Formation, and have been included with the Matinenda Formation of the Elliot Lake Group.

Mossman and Harron (1983) also suggest that the nondiabase related quartz and quartz-carbonate vein occurrences may be related to ancient paleoplacers from which the gold has been redistributed by diagenetic and metamorphic processes.

Much work has also been done in recent years by the Ontario Geological Survey and others in studying paleoplacer deposits and attempting to establish environments favourable to the formation of paleoplacer deposits within the Huronian Supergroup both west and north of the southern Cobalt Embayment. Wood (1980) reports that the lowermost part of the Huronian succession northwest, north and northeast of Lake Wanapitei includes conglomerate, pebbly sandstone, immature sandstone and mudstone, with radioactive minerals in the conglomerate. This part of the sequence is poorly exposed, extensively deformed and poorly understood, but Wood considers it to be of the greatest economic interest. He reports a value of 280 ppb gold from a basal conglomerate in Maclennan Township. Long (1981) studied the sedimentary framework of placer gold concentrations in basal Huronian strata of the Cobalt Embayment. He found the best values of up to 240 and 350 ppb in conglomerate and plane laminated, medium-grained sandstones characterized by a high pyrite content, from within the lowest part of the sequence. Meyn and Matthews (1980) found anomalous gold concentrations of up to 800 ppb in the same stratigraphic position. Long (1986) notes that the highest concentrations of gold are found where significant reworking of the coarser part of the sedimentary pile has occurred. Sauerbrei and Phipps (1983) report anomalous values including 809 ppb over 0.7 m in conglomerates near the base of the Huronian section, intersected in deep drill holes. However, Long and Lloyd (1983) concluded the potential for large deposits in basal Huronian strata of the Elliot Lake Group in the Sudbury-Blind River area is low, as coarse fluvial clastics which may have contained placers are comparatively rare.

Gossans on outcrops of Bruce Formation conglomerate in Falconbridge Township are reported by Dressler (1986). He also reports that in several places in Falconbridge Township, Serpent Formation arkose exhibits a rusty stain due to the presence of minor amounts of sulphide mineralization. Sauerbrei and Phipps (1983) report an intersection of 0.6 m of Serpent Formation subarkose grading 965 ppb gold from a deep drill hole approximately 20 km north of the limit of this study. Weak concentrations of pyrite are present on several bedding planes in the sample.

Donaldson et al. (1985) note that previous studies indicate the lower Gowganda Formation has little potential for paleoplacer gold (Long 1981; Long and Leslie 1982; Mossman and Harron 1983, 1984). However, Donaldson et al. (1985) felt there is a source of gold in the immediate Cobalt area. They considered it possible that gold may have been concentrated in placers in the lower Gowganda Formation, which in that area is the lowermost formation of the Huronian Supergroup present. After mapping and sampling the lower Gowganda Formation, they concluded that it holds little paleoplacer potential for gold. Colvine (1981, 1982) looked for paleoplacer gold occurrences in the Lorrain Formation in the northern Cobalt Embayment, because it too had possible sources of gold nearby, and sedimentologic characteristics that might provide for paleoplacer concentrations. Long and Colvine (1984, 1985) indicate that the best potential for placer-related gold occurrences is in the hematitic sandstone member of the Lorrain Formation. Of 215 samples, the maximum *in situ* value for gold was 1060 ppb. It was obtained from a nonpebbly trough cross-bedded unit from the hematitic sandstone member, some 100 km north of the southern Cobalt Embayment. They also note that high values are concentrated in the northern part of their study area, which ranges from 60 to 100 km north of the present one. Lowey (1985) studied the Lorrain Formation between Sault Ste. Marie and Elliot Lake. He concluded the hematitic member of the Lorrain Formation also holds the most potential for paleoplacers in that area.

Samples were collected in this study from every formation in the Huronian Supergroup except the Copper Cliff Formation in an attempt to identify paleoplacer concentrations in the southern Cobalt Embayment. Samples containing sulphide minerals, and samples containing evidence of reworking which might have led to selective concentration of heavy detrital minerals were preferentially selected. The results of trace element geochemical analyses of 52 samples by the Geoscience Laboratories, Ontario Geological Survey, Toronto, are listed in Table 18 of Appendix 2, and are summarized in Table 12 of Appendix 2 . Samples from all formations but the Matinenda contain only trace to low amounts of gold. Samples from the Matinenda Formation contain weakly anomalous amounts of gold, with the best values present in gritty to pebbly wacke. Gold contents are not as high as those reported for samples from the same stratigraphic position approximately 20 km to the northwest (Meyn and Matthews 1980; Long 1981).

Ten chip samples of quartz from veinlets in stockworks hosted by rocks of the McKim, Mississagi, Bruce and Serpent formations were analyzed by the Geoscience Laboratories. The results are listed in Table 18 of Appendix 2, and are summarized in Table 13 of Appendix 2. Stockworks of this type (Photo 25) have not been previously reported in the southern Cobalt Embayment. They are post-Gowganda Formation and pre-Sudbury Breccia in age, and consist of swarms of quartz veinlets up to 1 cm wide and 2 to 25 cm apart with irregular orientations to sets of two or three preferred orientations. There is minor propylitic wall rock alteration along the margins of the veinlets, and rare pyrite is present in and adjacent to the veinlets. The stockworks observed are from 3 by 5 to 20 by 100 m in area. The samples contained up to 400 ppb gold, but most had only trace to low amounts.

Quartz and quartz-carbonate veins in the southern Cobalt Embayment are described by Dressler (1982, 1986). The veins are a few centimetres to 18 m thick, and are present at or near the contacts of Nipissing gabbro bodies. These veins may contain one or more of native gold, pyrite and chalcopyrite, and near Kukagami Lake they also contain galena. Talc-actinolite and strong propylitic alteration are present along the margins of some veins. Dressler (1982) reports that a radiometric model age date determined from galena from one occurrence is 1500 to 1600 Ma. Two samples of altered Nipissing gabbro wall rock, and seven samples of quartz and quartz-carbonate vein material were analyzed by the Geoscience Laboratories, Ontario Geological Survey (Table 15 of Appendix 2). Both samples of altered gabbro, which were from properties several kilometres apart, contained 8 ppb gold. The samples of quartz and quartz-carbonate vein material contained up to 6350 ppb gold. Native gold was visible in the highest grade sample. Five of the samples contained less than 40 ppb gold, and two, again from properties several kilometres apart, contained 470 and 490 ppb gold.

Meyer (1986, 1987) reports that soda metasomatism of Huronian Supergroup rocks occurs from near Sault Ste. Marie to perhaps as far east as Cobalt. Four samples of metasomatized conglomerate, siltstone and arkose from the Quirke Lake Group were chemically analyzed. The results are presented in Table 14 of Appendix 2.

Photo 25. Fine quartz vein stockwork in Serpent Formation arkose. Traverse 35, central Street Township.

Soda values range from 4.69 to 10.1 percent in these samples and are enhanced over the values found in unaltered rocks of the same formation in every case. The locations of the outcrops sampled are shown on the sample location map (*see* Figure 5, back pocket). Replacement in the metasomatites ranges from incipient to nearly 100 percent by albite. The alteration is thought to have occurred between 1.85 and 1.2 Ga, and is post-Nipissing gabbro, pre-olivine diabase, and post-Sudbury Igneous Complex.

The metasomatized rocks may be massive or strongly brecciated (Photo 26), with several types of breccia possible. Sodic metasomatism appears to have been the first alteration event. East of Wanapitei Lake the paragenesis appears megascopically to have been albite, followed by carbonate rhombohedra (Photo 27), and quartz or chlorite. Secondary chemical events may include quartz flooding, introduction of carbonate, chloritization, sulphide introduction and introduction of copper-gold minerals. In three thin sections of Gowganda Formation argillite microbreccia examined during this study, the paragenesis appears the same. The microbreccia is crosscut by thin veinlets up to 1 mm wide, with chlorite along the margins, and albite in the centre of the veinlets. Some replacement of matrix by albite may also have occurred. In all three sections, chlorite is present in the thinnest veins. Chlorite plus quartz and albite are present in medium veins, and quartz and euhedral albite, with very minor chlorite are present in the widest veins. The potential size of this type of occurrence is reflected by published reserves from the Scadding Gold Mine, Scadding Township. Reserves were reported to be 28 060 tons grading 0.205 ounce per ton, and 9417 tons grading 0.107 ounce per ton (*The Northern Miner*, January 26, p.6, 1984). After 24 000 tons averaging 0.199 ounce per ton were mined (*The Northern Miner*, May 23, 1985), new reserve figures totalling 136 496 tons of 0.21 ounce per ton were published (*The Northern Miner*, February 10, 1986).

Eight samples of metasomatically altered rock from the Espanola and Gowganda formations were analyzed by the Geoscience Laboratories, Ontario Geological Survey. The results of the analyses are listed in Table 18 of Appendix 2, and are summarized in Table 15 of Appendix 2. Four samples of altered Espanola Formation rock, which consisted of albitized siltstone and fine-grained arkose with some very finely disseminated pyrite, contained up to 13 ppb gold. A fifth sample of albitized Espanola Formation with less than 1 percent pyrite up to 0.25 mm across contained 1790 ppb gold and 200 ppm arsenic. Three samples of altered Gowganda Formation rock, which consisted of chloritized breccia and microbreccia with quartz and albite vein fillings, contained up to 5 ppb gold.

Few of the rock types present in the southern Cobalt Embayment show evidence of the prolonged reworking and winnowing. Pyritic polymictic orthoconglomerates and pebbly wackes at and near the base of the Huronian Supergroup in Maclennan and Falconbridge townships, and polymictic orthoconglomerate in the uppermost Stobie Formation in Falconbridge Township hold the greatest potential for placer concentrations of gold. These conglomerates are of limited lateral and vertical extent. The hematitic sandstone member of the

Photo 26. Chloritized breccia and chlorite-albite-quartz veining in Serpent Formation arkose at the Scadding Mine. Traverse 49, south-central Scadding Township.

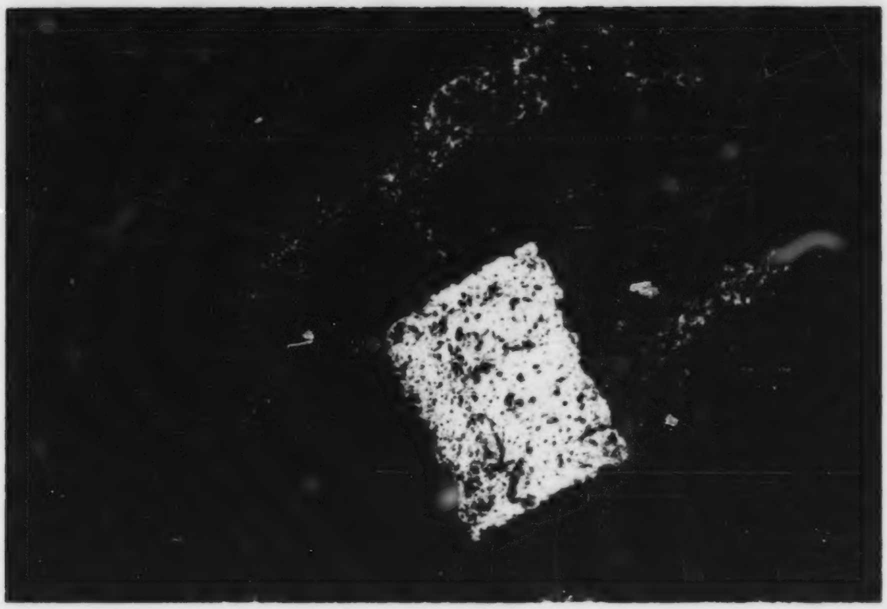


Photo 27. Carbonate rhombohedra in metasomatized microbreccia in Gowganda Formation siltstone. Plane light, field of view 2 mm across. Sample 86RLD-3101, Traverse 31, south-central Scadding Township.

Lorrain Formation present in the northern part of the southern Cobalt Embayment may hold some potential for paleoplacer deposits, but studies farther north indicate that the potential is low. One sample of pyritic Stobie Formation basalt contained 350 ppb gold, and may indicate some potential for gold deposits within the volcanic rocks of the Huronian Supergroup.

Quartz and quartz-carbonate veins hold some potential for economic gold mineralization, whatever the source of the gold in them may be. The low grades of gold in the sediments of the Huronian Supergroup do not support paleoplacer concentrations as a source of gold in the veins. There is limited evidence that the quartz and quartz-carbonate veins may be related to the metasomatic alteration present in the area. Mineralized metasomatized sedimentary rocks, particularly in the Espanola and Serpent formations, and the possible link between mineralization in the quartz and quartz-carbonate veins and the metasomatized rocks are worthy of further study.

Appendix 1 – Stratigraphic Columns

The locations of the traverses shown on Figure 3 (*see* back pocket), were selected in order that as complete a section as possible could be measured along each line. The amount of outcrop, the absence of structural complications such as faulting, folding and Sudbury breccia bodies, and the absence of intrusive bodies of Nipissing gabbro were all important considerations in selecting the traverse locations. An attempt was made to measure sections across each formation in as many places as possible, and to examine the upper and lower contacts of each formation in at least two places.

Stratigraphic columns based on the traverses were plotted on charts adapted after those of Long (1986). Columns were not drawn for seven traverses (Traverses 1, 18, 24, 25, 47, 49, 59) because deformation encountered during the traverse would have made a column meaningless, or because the traverse was done to check a specific site rather than to measure a section. Table 1 of this Appendix lists the traverses which cover each formation, along with the parts of the formation covered and the geographic locations of the traverses.

The thicknesses measured for the various units during the traverses were not true thicknesses, but rather were apparent thicknesses controlled both by the angle between the traverse direction and the strike of the strata, and by the dip of the strata. Corrections for both of these controls were made, and the calculated true thicknesses were used in drawing the stratigraphic columns.

The thicknesses of the various units are indicated along the left edge of the stratigraphic column chart. Most sections were drawn at a scale of 20 m per interval, but a few were drawn at 10 m per interval, and two sections were drawn at 5 m per interval. The scale used was determined by the complexity of the measured section.

Immediately to the right of the scale bar, some sections have one or more solid dots, squares or triangles, or open circles. These symbols indicate that petrologic or geochemical analysis of a sample taken from that position in the section was carried out. The symbols are explained in the legend for the stratigraphic columns.

The thicknesses of rock units, and the grain size and general lithology of those units are indicated in the same portion of the chart as the symbols mentioned above. The thickness of the unit is indicated by the distance it extends along the scale bar. The grain size of the rocks in the unit is indicated by symbols and numbers at the tops and bottom of the chart. The grain size intervals are after Wentworth (*in* Folk 1968), and are summarized in Table 2 of this Appendix. In the case of conglomerates and pebbly wackes, the grain size indicated is that of the coarsest commonly occurring size of clast. Rare coarser clasts may be present in the conglomeratic units. The general lithology present is indicated by the pattern which fills in that portion of the section. The patterns are indentified in the legend for the stratigraphic columns. Where a narrow bar with no pattern, or with a cross mark in it is present along the left margin of the chart, a covered interval occurs in the section.

The section of the chart to the right of the part indicating grain size and general lithology consists of a series of narrow vertical columns. Where equal proportions of coarser- and finer-grained material are interbedded, the bed thicknesses of the coarser-grained material are indicated by solid bars, and the bed thicknesses of the finer-grained material are indicated by open columns marked with crosses. The bed thickness intervals are indicated by numbers at the top and bottom of the chart. They are adapted from Ingram (*in* Krumbein and Sloss 1963), and are summarized in Table 3 of this Appendix. Where the bed thicknesses of the units present could not be determined, this section of the chart was left blank.

A narrow column to the right of the part indicating bed thicknesses may contain one or more four-digit numbers, and a notation such as T-7. The four-digit numbers lie opposite symbols indicating that petrologic or geochemical analysis has been done, and are the numbers of the samples analyzed. Each sample number should be preceded by 86RLD. Notations such as T-7 occur where more than one traverse was used to make the stratigraphic section. The notations indicate the traverse (T) from which that part of the section was drawn.

A second series of narrow vertical columns indicates the depositional features present in the rock units. The depositional features and the numbers representing them are summarized in Table 4 of this Appendix. Where equal proportions of coarser- and finer-grained material are interbedded, depositional features in the coarser-grained material are indicated by solid bars, and depositional features in the finer-grained material are indicated by open columns marked with crosses.

The wide section at the right of the chart contains comments concerning the lithology, matrix composition, bed contact relationships, depositional features, and other characteristics of the units in the stratigraphic column. Abbreviations used in this section are included in the legend for stratigraphic columns.

TABLE 1. STRATIGRAPHIC SECTIONS ACROSS THE HURONIAN SUPERGROUP, SOUTHERN COBALT EMBAYMENT.

			Formation part			Contacts	
Formation	**Traverse**	**Township**	**lower**	**middle**	**upper**	**lower**	**upper**
Stobie	2	Falconbridge		x	x		
	19	Falconbridge			x		
	27	Falconbridge			x		
Copper Cliff	53	McKim			x		x
Matinenda	23	Maclennan	x	x	x	x	x
	25	Maclennan	x	x		x	
	26	Maclennan	x	x		x	
McKim	53	McKim	x			x	
	55	McKim		x			
	56	McKim			x		x
	60	McKim	x	x			
Ramsay Lake	14	Neelon		x	x		
	15	Neelon			x		x
	16	Falconbridge		x	x		x
	20	Falconbridge		x	x		
	37	Garson		x	x		x
	52	Neelon			x		x
	56	McKim	x			x	
	57	McKim		x	x		x
Pecors	14	Neelon		x	x		
	15	Neelon	x	x	x	x	
	16	Falconbridge	x	x	x	x	
	23	Maclennan	x	x	x	x	
	26	Maclennan	x	x	x		x
	37	Garson	x	x	x		x
	50	McKim			x		x
	51	McKim		x	x		x
	52	Neelon	x	x	x	x	x
	57	McKim	x			x	
Mississagi	3	Garson		x			
	4	Garson	x				
	5	Garson		x			
	6	Falconbridge		x			
	7	Falconbridge		x			
	8	Falconbridge			x		
	9	Falconbridge			x		x
	10	Falconbridge			x		x
	13	Falconbridge			x		x
	14	Neelon	x				
	15	Neelon	x				
	16	Falconbridge	x				
	20	Falconbridge	x				
	21	Falconbridge	x				
	22	Maclennan	x				
	23	Maclennan	x				
	26	Maclennan	x			x	
	33	Street			x		
	34	Street			x		
	36	Davis			x		
	37	Garson	x			x	
	38	Neelon		x			
	39	Neelon		x			
	40	Neelon		x			
	41	Falconbridge	x				
	42	Dryden			x		x
	50	McKim	x			x	
	51	McKim	x			x	
	52	Neelon	x			x	
	54	Neelon	x	x			

TABLE 1. (Continued)

Formation	Traverse	Township	Formation part			Contacts	
			lower	middle	upper	lower	upper
Bruce	9	Falconbridge	x			x	
	10	Falconbridge	x				
	11	Falconbridge		x	x		
	12	Falconbridge			x		x
	13	Falconbridge	x			x	
	17	Scadding			x		
	29	Scadding	x	x			
	34	Street		x	x		
	35	Street		x	x		
	42	Dryden	x	x		x	
	43	Dryden		x	x		
	44	Dryden			x		x
	46	Scadding			x		
	48	Scadding			x		
Espanola	13	Falconbridge		x			
	17	Scadding			x		
	28	Falconbridge		x	x		x
	29	Scadding			x		
	44	Dryden	x			x	
	46	Scadding	x	x			
	48	Scadding	x				
Serpent	12	Falconbridge	x			x	
	17	Scadding	x				
	28	Falconbridge	x			x	
	29	Scadding	x				
	30	Scadding		x	x		x
	32	Scadding			x		
	35	Street	x	x			
	46	Scadding		x			
Gowganda	30	Scadding	x			x	
	31	Scadding	x	x			
	32	Scadding	x	x			
	45	Rathbun			x		
	47	Scadding			x		
Lorrain	45	Rathbun	x				
	58	Rathbun	x	x			

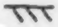
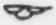
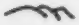
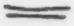
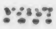
TABLE 2. GRAIN SIZE INTERVALS USED IN STRATIGRAPHIC COLUMNS.

Symbol	Size range (mm)	Size class
s	< 0.06	silt and clay
vf	0.06–0.125	very fine sand
f	0.125–0.25	fine sand
m	0.25–0.50	medium sand
c	0.50–1.00	coarse sand
vc	1.00–2.00	very coarse sand
g	2.00–4	granule
	4–8	pebble
	8–16	pebble
	16–32	pebble
	32–64	pebble
	64–256	cobble
	> 256	boulder

TABLE 3. BED THICKNESS INTERVALS USED IN STRATIGRAPHIC COLUMNS.

Size range (cm)	Size class
0–0.3	thinly laminated
0.3–1	thickly laminated
1–3	very thinly bedded
3–10	thinly bedded
10–30	medium bedded
30–50	thickly bedded
50–100	thickly bedded
100–150	very thickly bedded
150–300	very thickly bedded
> 300	extremely thickly bedded

TABLE 4. DEPOSITIONAL FEATURES IDENTIFIED IN STRATIGRAPHIC COLUMNS.

Number		Feature
1		individual beds massive
2		planar cross-bedding
3		trough cross-bedding
4		convex upward cross-laminated cross-beds
5		ripple cross-laminations
6		parallel laminations or bedding
7		graded bedding
8		load casts or flame structures
9		dropstones

LEGEND

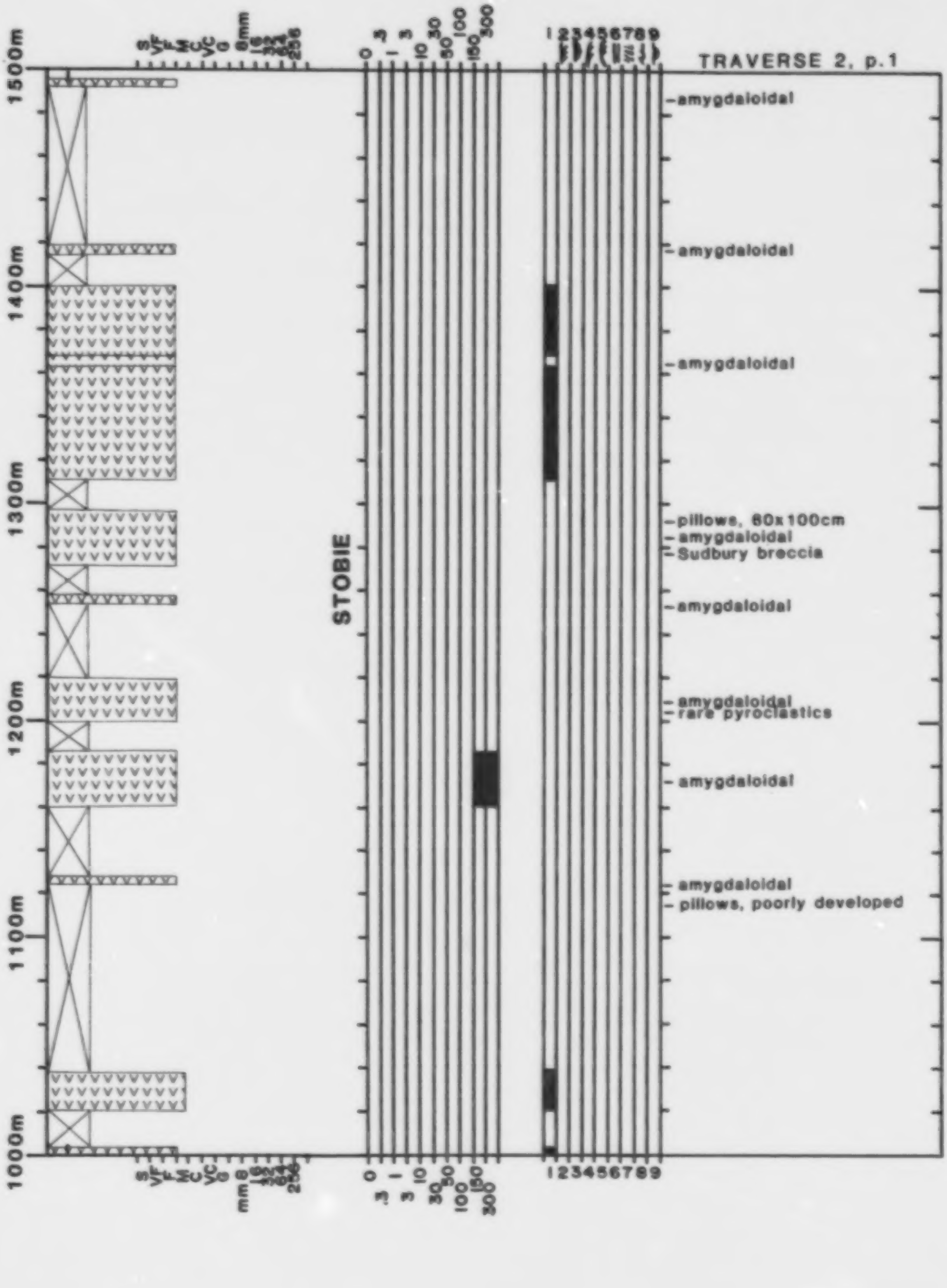
▤	Siltstone
□	Sandstone and wacke
▤	Interbedded sandstone or wacke and siltstone
▒	Pebbly sandstone or wacke. Up to 5% clasts; clasts of any size
▓	Conglomerate. More than 5% clasts; clasts of any size
V V V V	Felsic and mafic volcanic rocks
▦	Interbedded parallel-laminated limestone and calcareous siltstone to fine-grained arkose
▧	Granite and granodiorite
+ +	Diabase, gabbro and metagabbro
☒	Covered interval

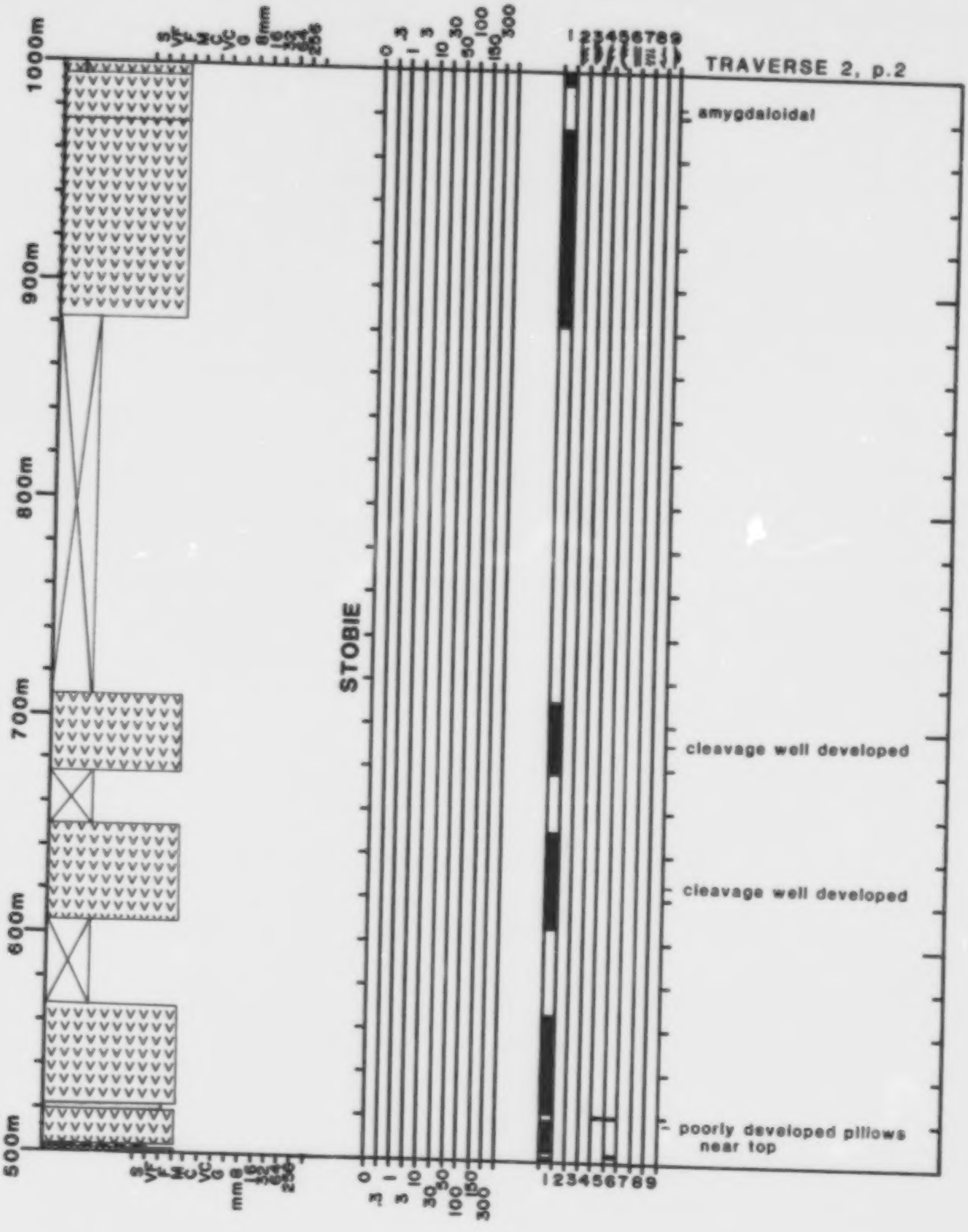
ABBREVIATIONS

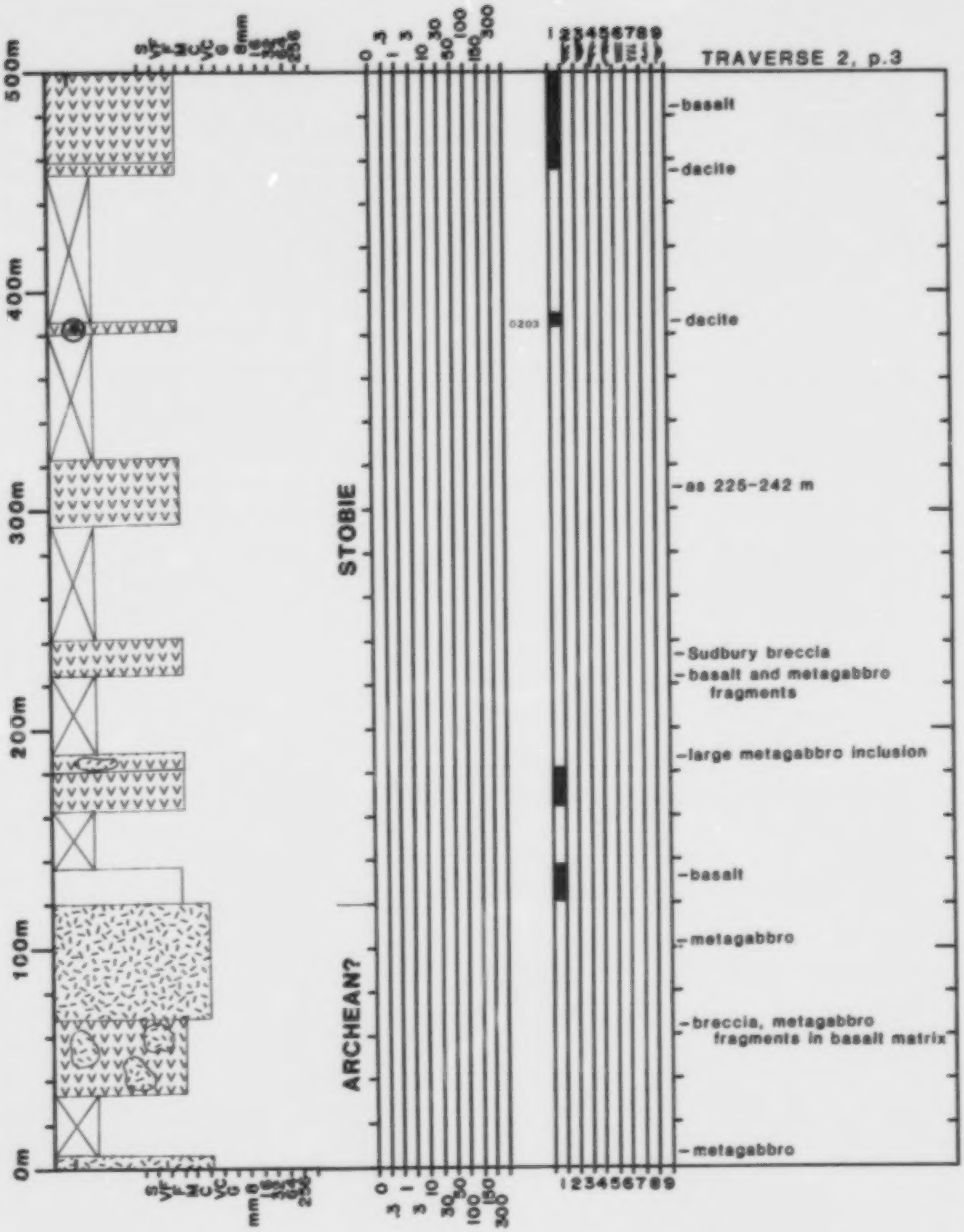
ARK	arkose
BCS	bed contacts scoured
CARB	carbonate
CB	cross-bedded
CG	coarse grained
CONG	conglomerate
DC	discontinuous
FG	fine grained
IB	interbedded
L	lunate
LST	limestone
MG	medium grained
MR	megaripples
PL	parallel laminated
QTZ	quartz
SC	straight-crested
SLTST	siltstone
SUBARK	subarkose

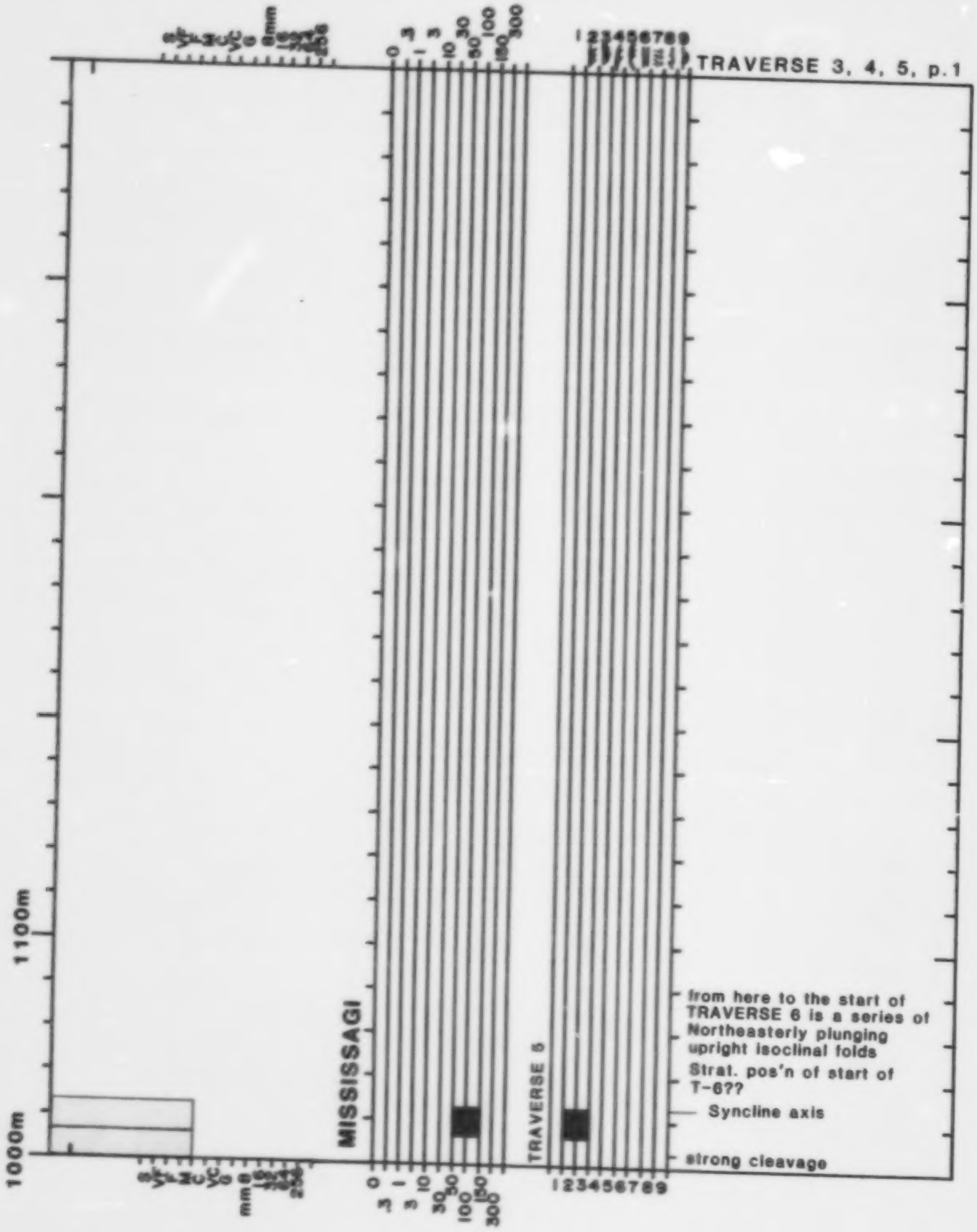
SYMBOLS

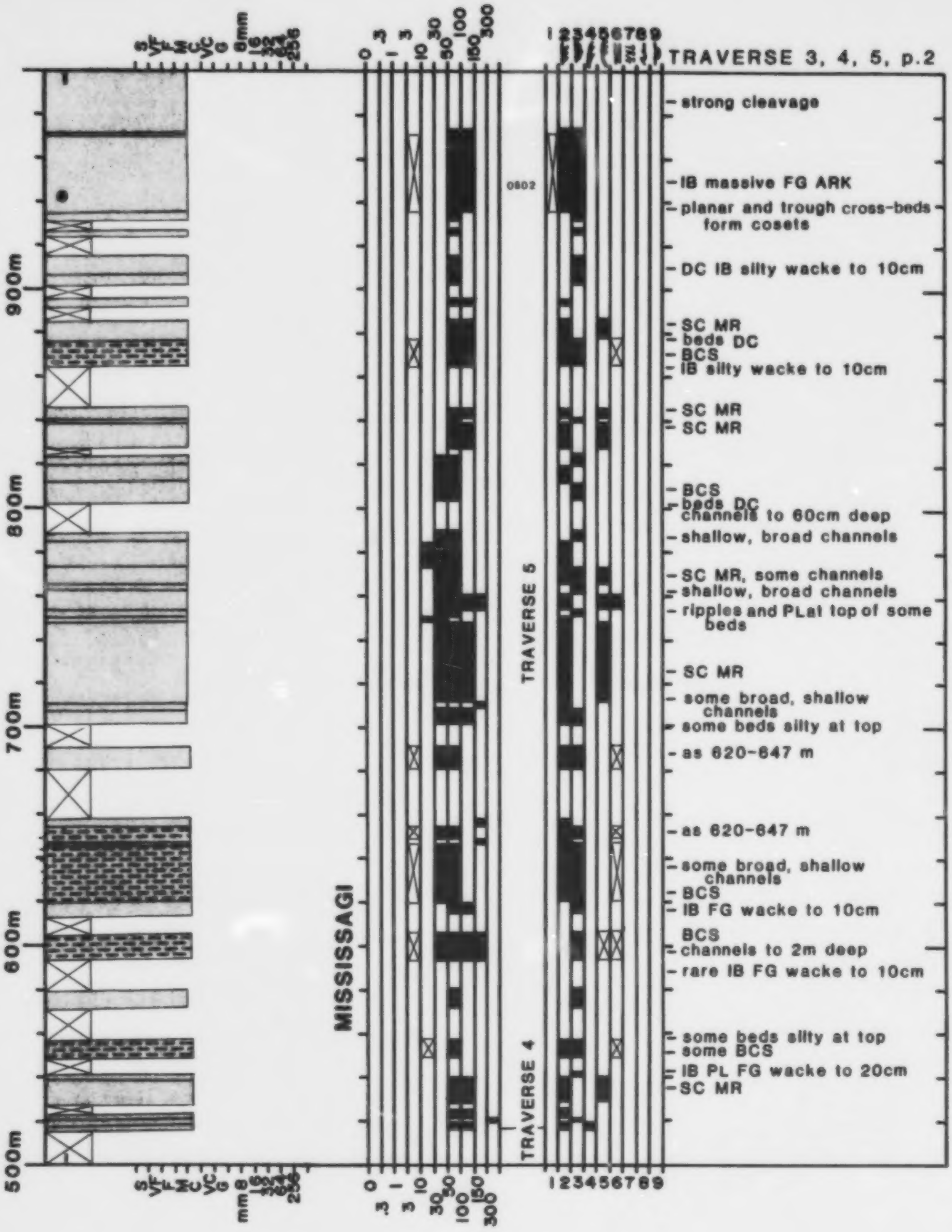
●	Sample has undergone petrographic analysis
▲	Sample has undergone trace element geochemical analysis
■	Sample has undergone petrographic and trace element geochemical analysis
○	Sample has undergone whole rock geochemical analysis (this symbol may be combined with any of the above symbols)
△ △ △	Breccia

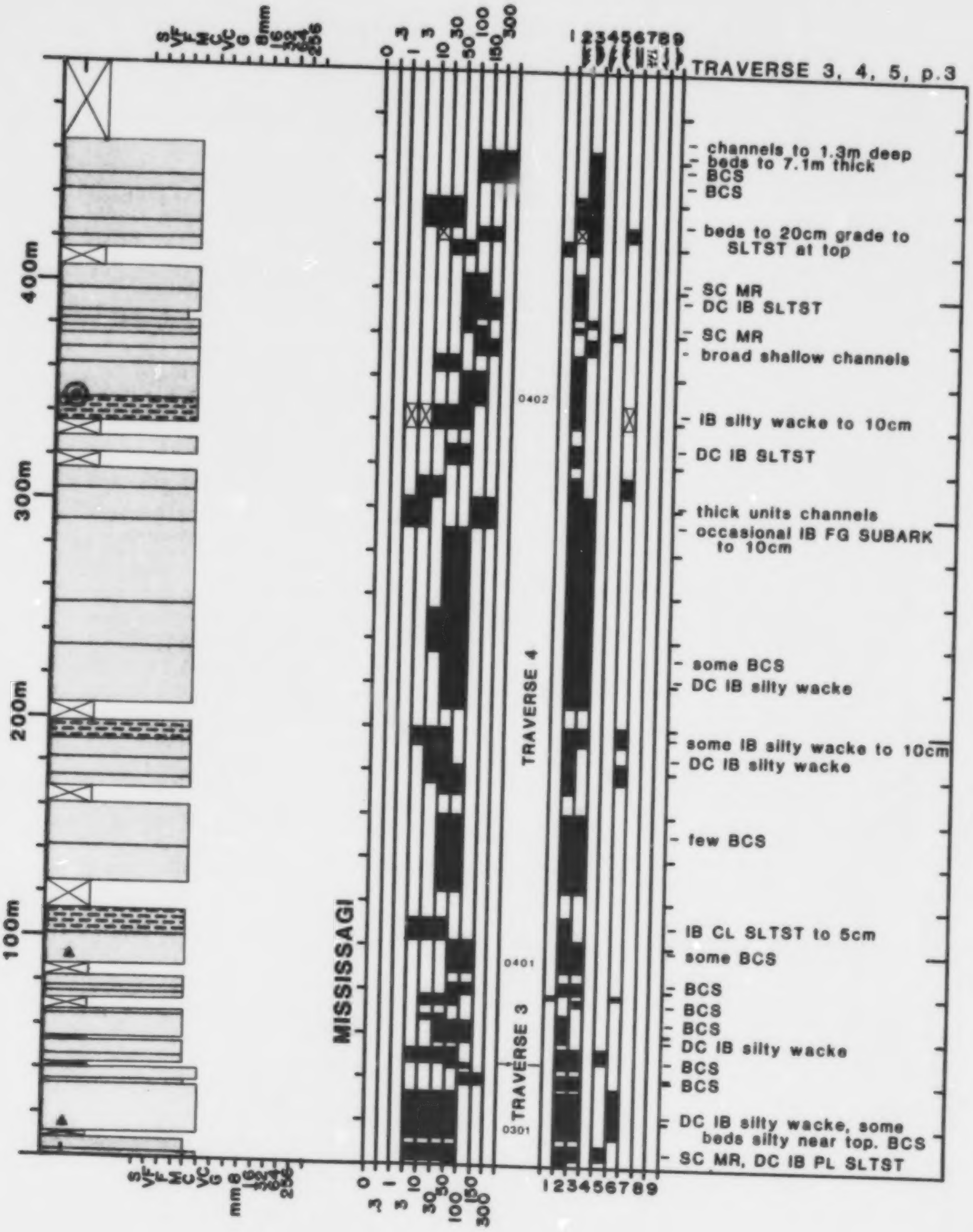

TRAVERSE 2, p.1
1500m
1400m
1300m
1200m
1100m
1000m
S VF F M C VC G
mm 8 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
STOBIE
amygdaloidal
amygdaloidal
amygdaloidal
pillows, 60x100cm
amygdaloidal
Sudbury breccia
amygdaloidal
amygdaloidal
rare pyroclastics
amygdaloidal
amygdaloidal
pillows, poorly developed

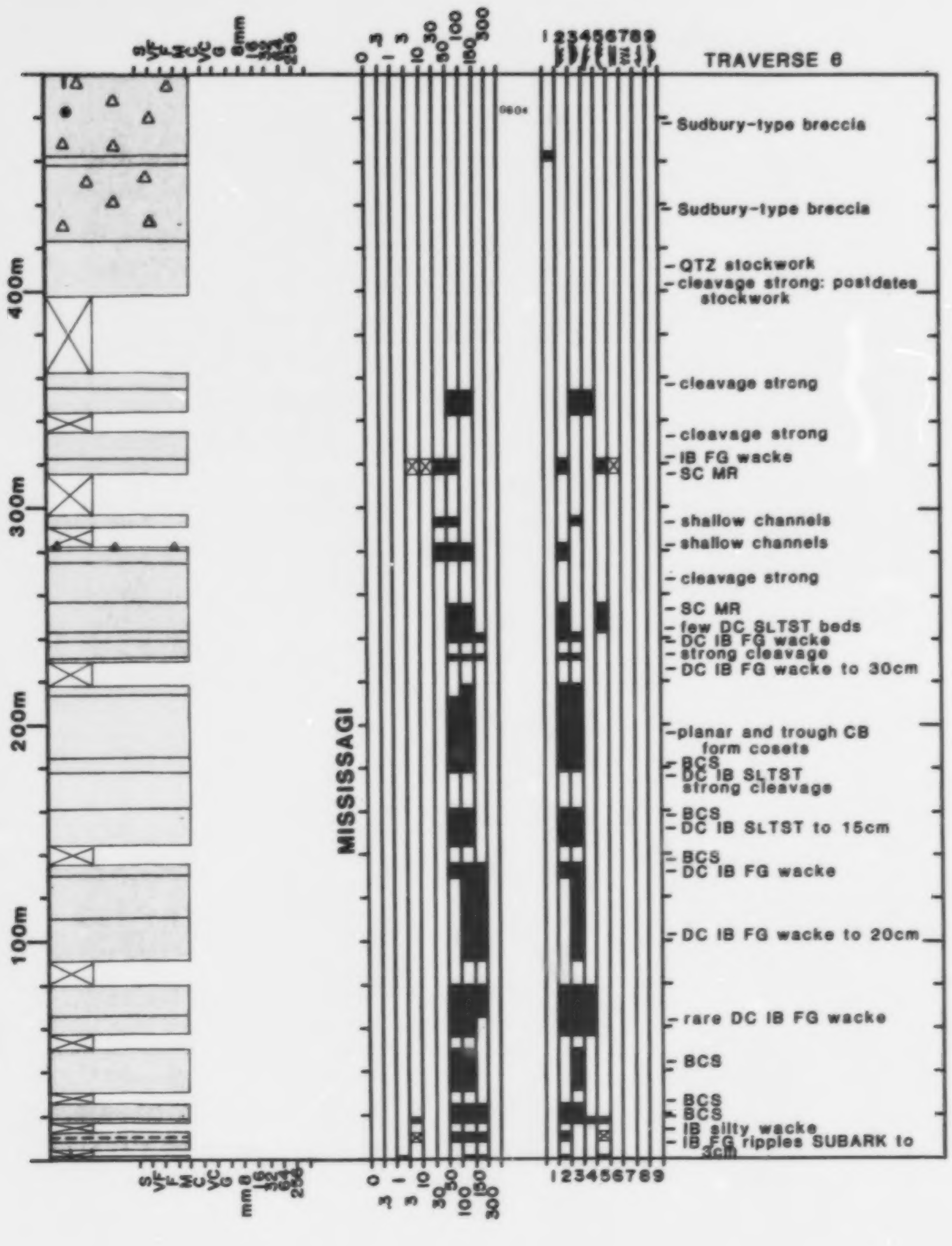

TRAVERSE 2, p.2
1000m
900m
800m
700m
600m
500m
S VF F M C VC G mm 8 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
STOBIE
amygdaloidal
cleavage well developed
cleavage well developed
poorly developed pillows near top

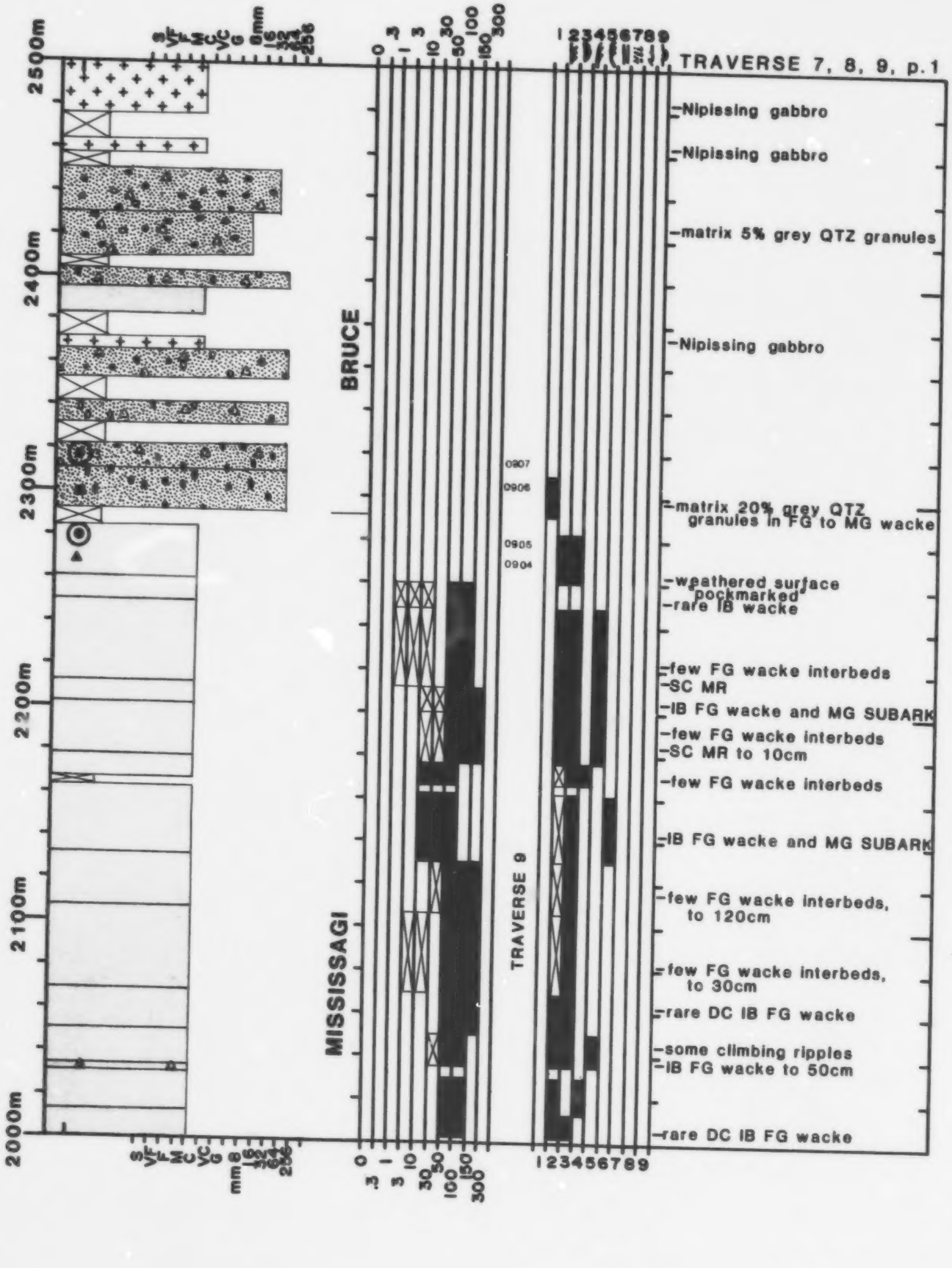

TRAVERSE 2, p.3
500m
400m
300m
200m
100m
0m
S VF F M C VC G 8mm 16 32 64 128 256
0 .5 1 3 5 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
0203
STOBIE
ARCHEAN?
-basalt
-dacite
-dacite
-as 225-242 m
-Sudbury breccia
-basalt and metagabbro fragments
-large metagabbro inclusion
-basalt
-metagabbro
-breccia, metagabbro fragments in basalt matrix
-metagabbro

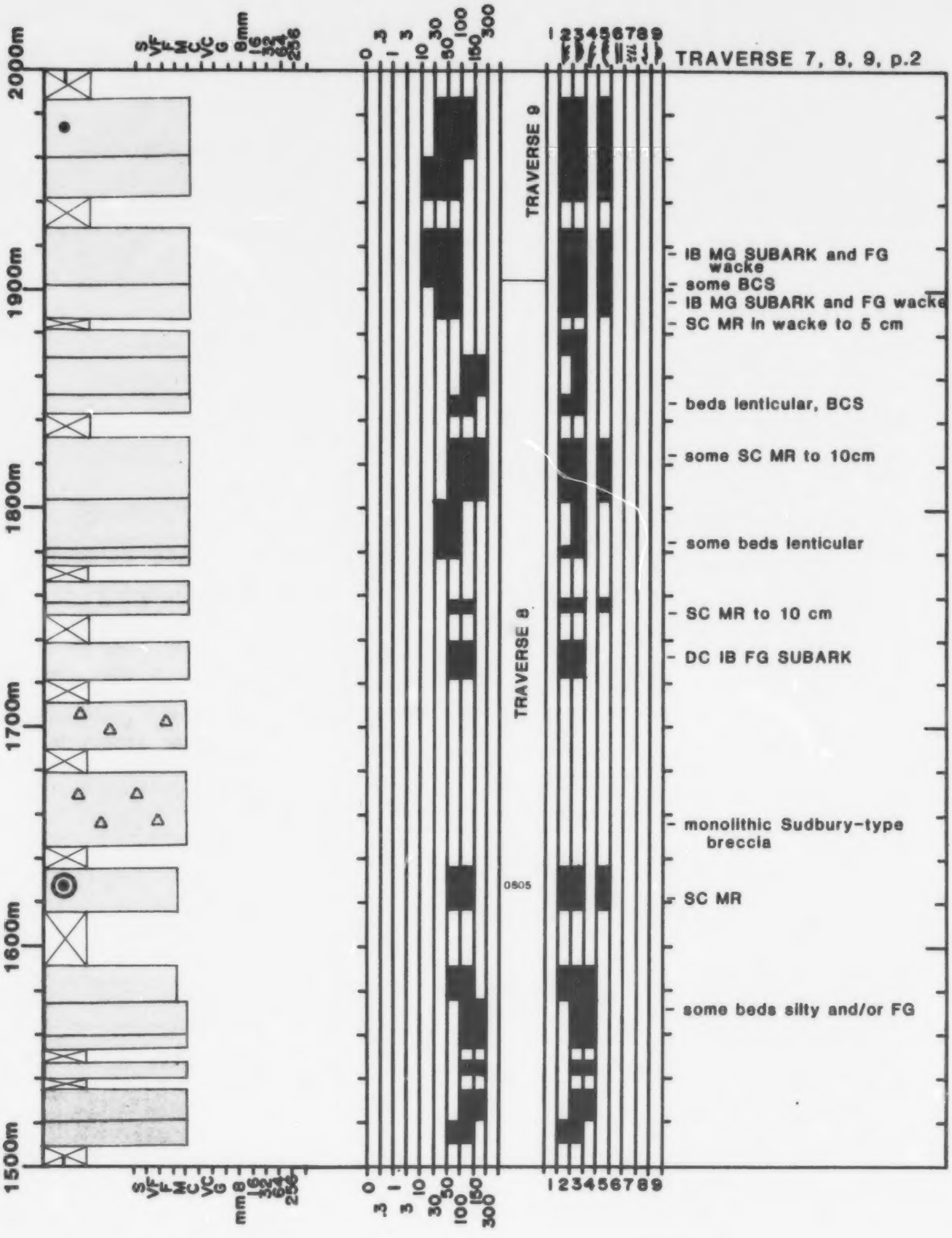

TRAVERSE 3, 4, 5, p.1
1000m
1100m
MISSISSAGI
TRAVERSE 5
0 .3 1 3 10 30 50 100 150 300
123456789
mm
from here to the start of TRAVERSE 6 is a series of Northeasterly plunging upright isoclinal folds
Strat. pos'n of start of T-6??
Syncline axis
strong cleavage

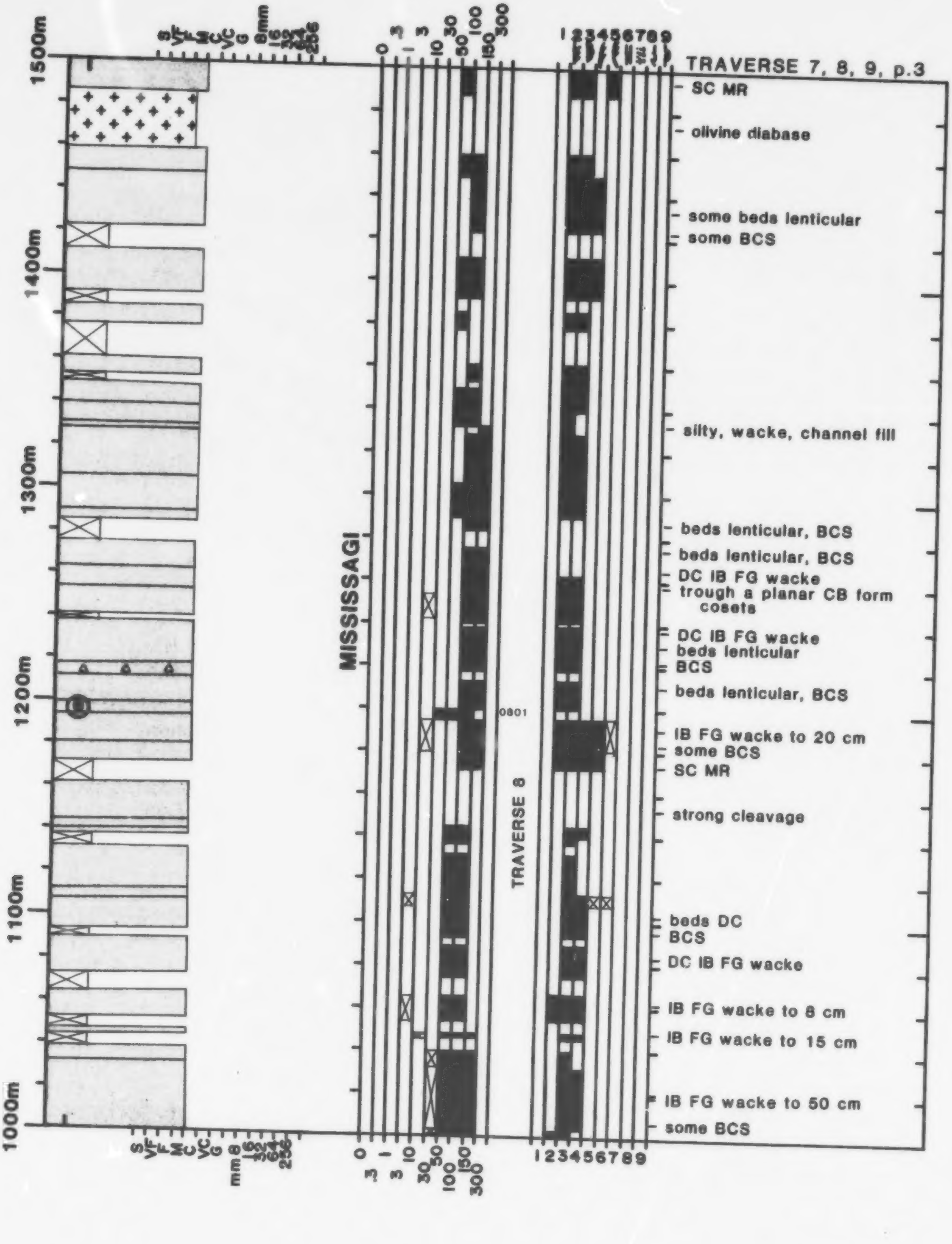

TRAVERSE 3, 4, 5, p.2
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
900m
800m
700m
600m
500m
MISSISSAGI
TRAVERSE 5
TRAVERSE 4
0802
strong cleavage
IB massive FG ARK
planar and trough cross-beds form cosets
DC IB silty wacke to 10cm
SC MR
beds DC
BCS
IB silty wacke to 10cm
SC MR
SC MR
BCS
beds DC
channels to 60cm deep
shallow, broad channels
SC MR, some channels
shallow, broad channels
ripples and PL at top of some beds
SC MR
some broad, shallow channels
some beds silty at top
as 620-647 m
as 620-647 m
some broad, shallow channels
BCS
IB FG wacke to 10cm
BCS
channels to 2m deep
rare IB FG wacke to 10cm
some beds silty at top
some BCS
IB PL FG wacke to 20cm
SC MR

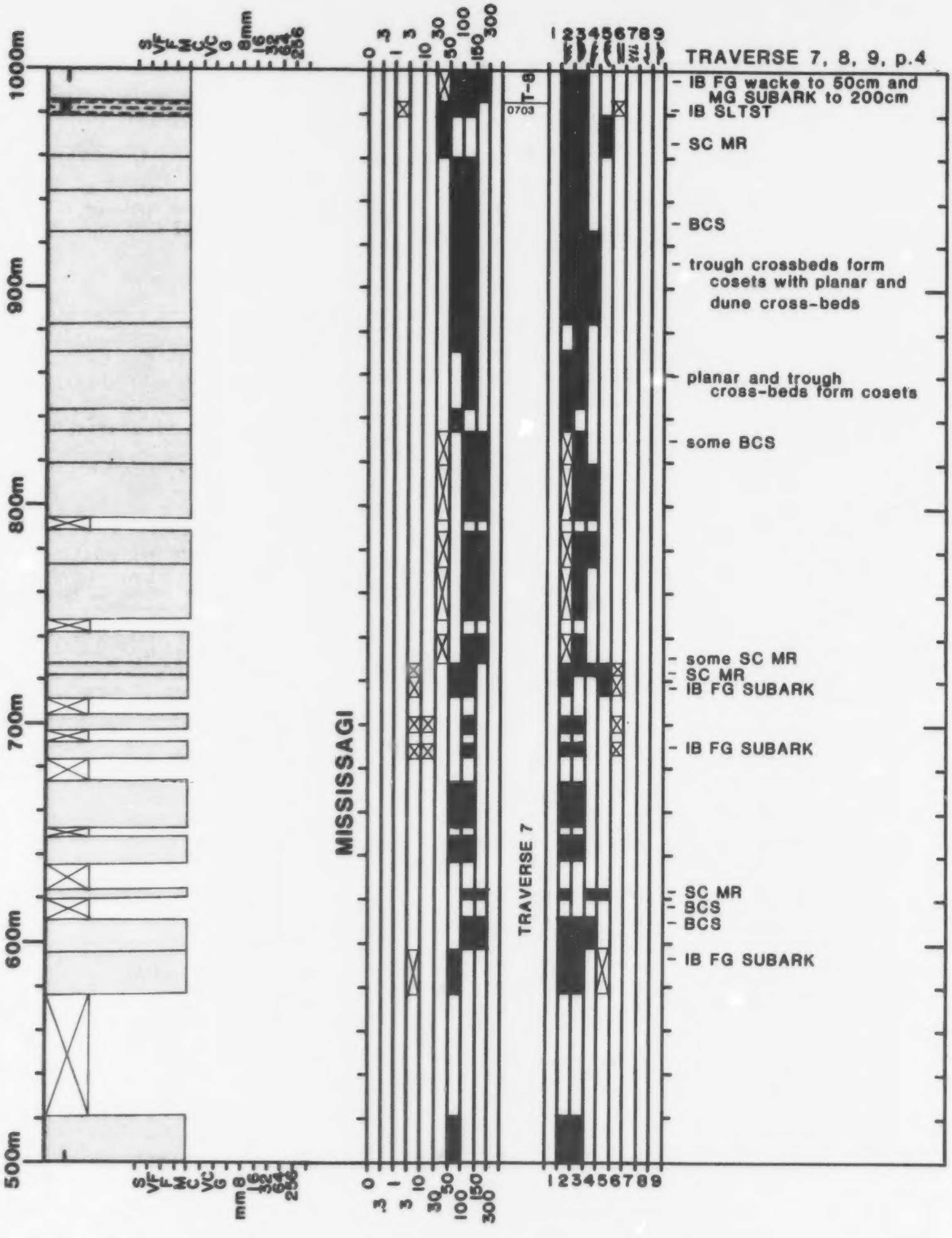

TRAVERSE 3, 4, 5, p.3
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
MISSISSAGI
TRAVERSE 4
TRAVERSE 3
0402
0401
0301
- channels to 1.3m deep
- beds to 7.1m thick
- BCS
- BCS
- beds to 20cm grade to SLTST at top
- SC MR
- DC IB SLTST
- SC MR
- broad shallow channels
- IB silty wacke to 10cm
- DC IB SLTST
- thick units channels
- occasional IB FG SUBARK to 10cm
- some BCS
- DC IB silty wacke
- some IB silty wacke to 10cm
- DC IB silty wacke
- few BCS
- IB CL SLTST to 5cm
- some BCS
- BCS
- BCS
- BCS
- DC IB silty wacke
- BCS
- BCS
- DC IB silty wacke, some beds silty near top. BCS
- SC MR, DC IB PL SLTST

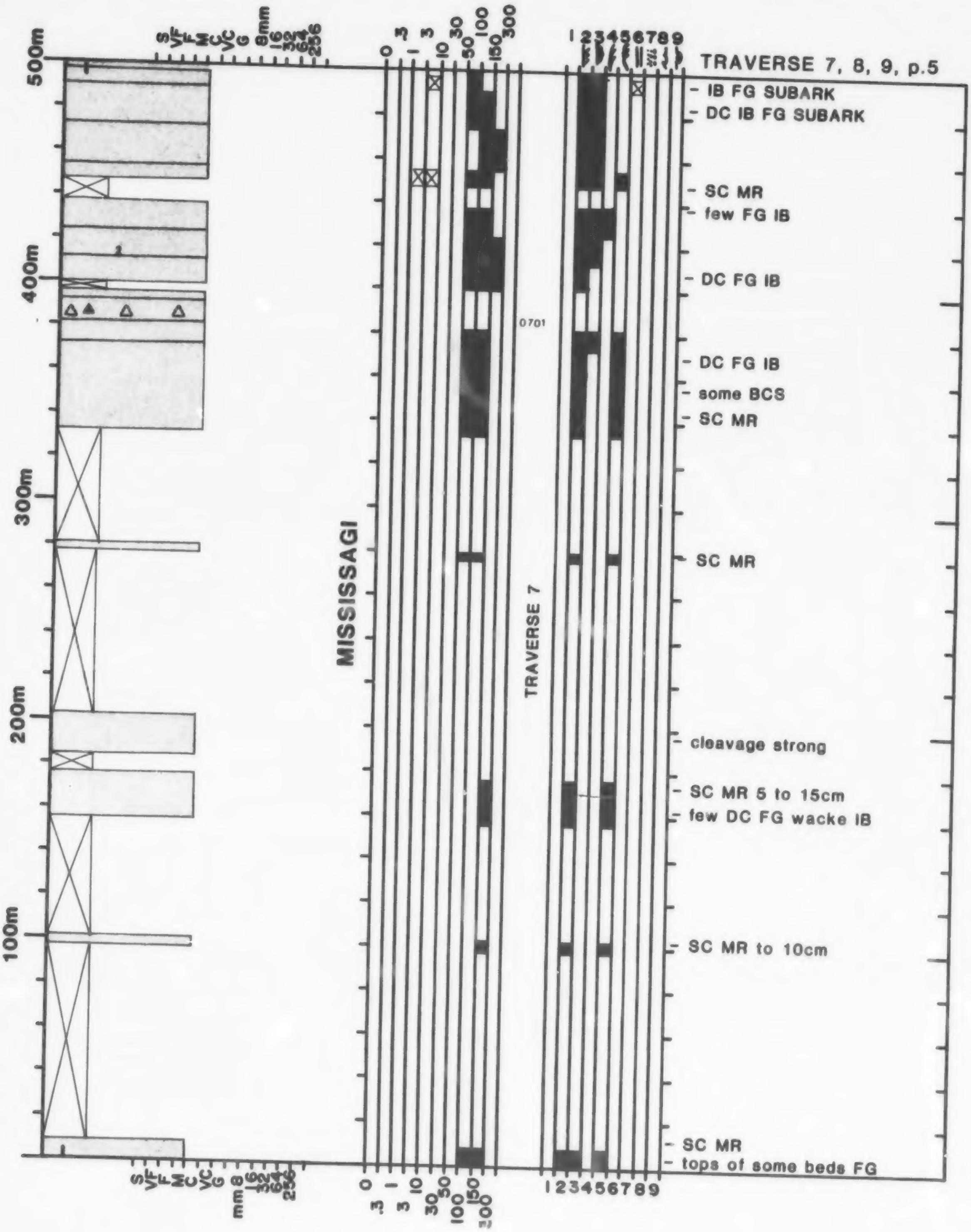

TRAVERSE 6
S VF F M C VC G 8mm 16 32 64 256
0 .5 1 3 10 30 50 100 150 300
123456789
400m
300m
200m
100m
MISSISSAGI
Sudbury-type breccia
Sudbury-type breccia
QTZ stockwork
cleavage strong: postdates stockwork
cleavage strong
cleavage strong
IB FG wacke
SC MR
shallow channels
shallow channels
cleavage strong
SC MR
few DC SLTST beds
DC IB FG wacke
strong cleavage
DC IB FG wacke to 30cm
planar and trough CB form cosets
BCS
DC IB SLTST strong cleavage
BCS
DC IB SLTST to 15cm
BCS
DC IB FG wacke
DC IB FG wacke to 20cm
rare DC IB FG wacke
BCS
BCS
BCS
IB silty wacke
IB FG ripples SUBARK to 3cm

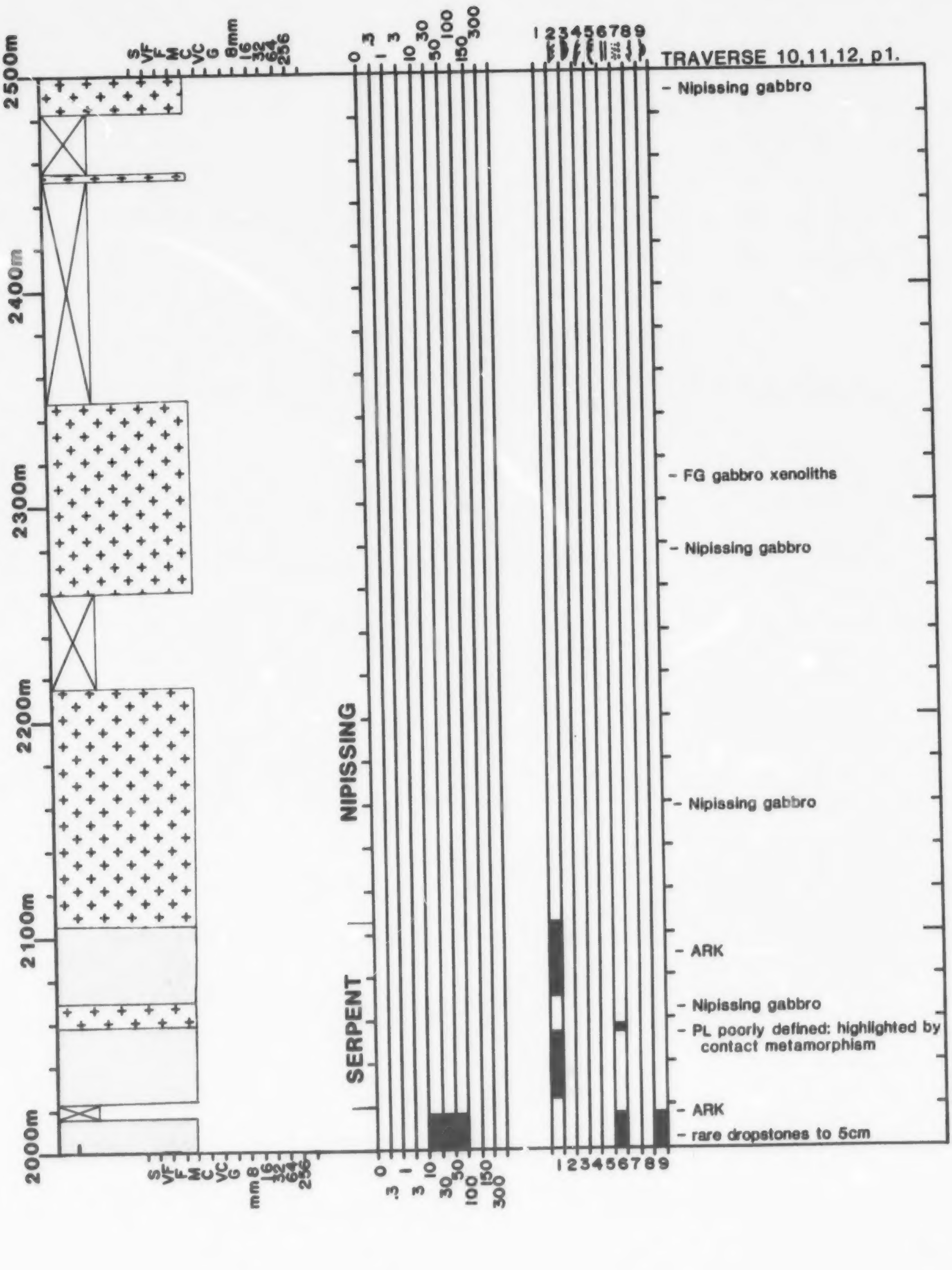

TRAVERSE 7, 8, 9, p.1
2500m
2400m
2300m
2200m
2100m
2000m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
BRUCE
MISSISSAGI
TRAVERSE 9
0907
0906
0905
0904
Nipissing gabbro
Nipissing gabbro
matrix 5% grey QTZ granules
Nipissing gabbro
matrix 20% grey QTZ granules in FG to MG wacke
weathered surface "pockmarked"
rare IB wacke
few FG wacke interbeds
SC MR
IB FG wacke and MG SUBARK
few FG wacke interbeds
SC MR to 10cm
few FG wacke interbeds
IB FG wacke and MG SUBARK
few FG wacke interbeds, to 120cm
few FG wacke interbeds, to 30cm
rare DC IB FG wacke
some climbing ripples
IB FG wacke to 50cm
rare DC IB FG wacke

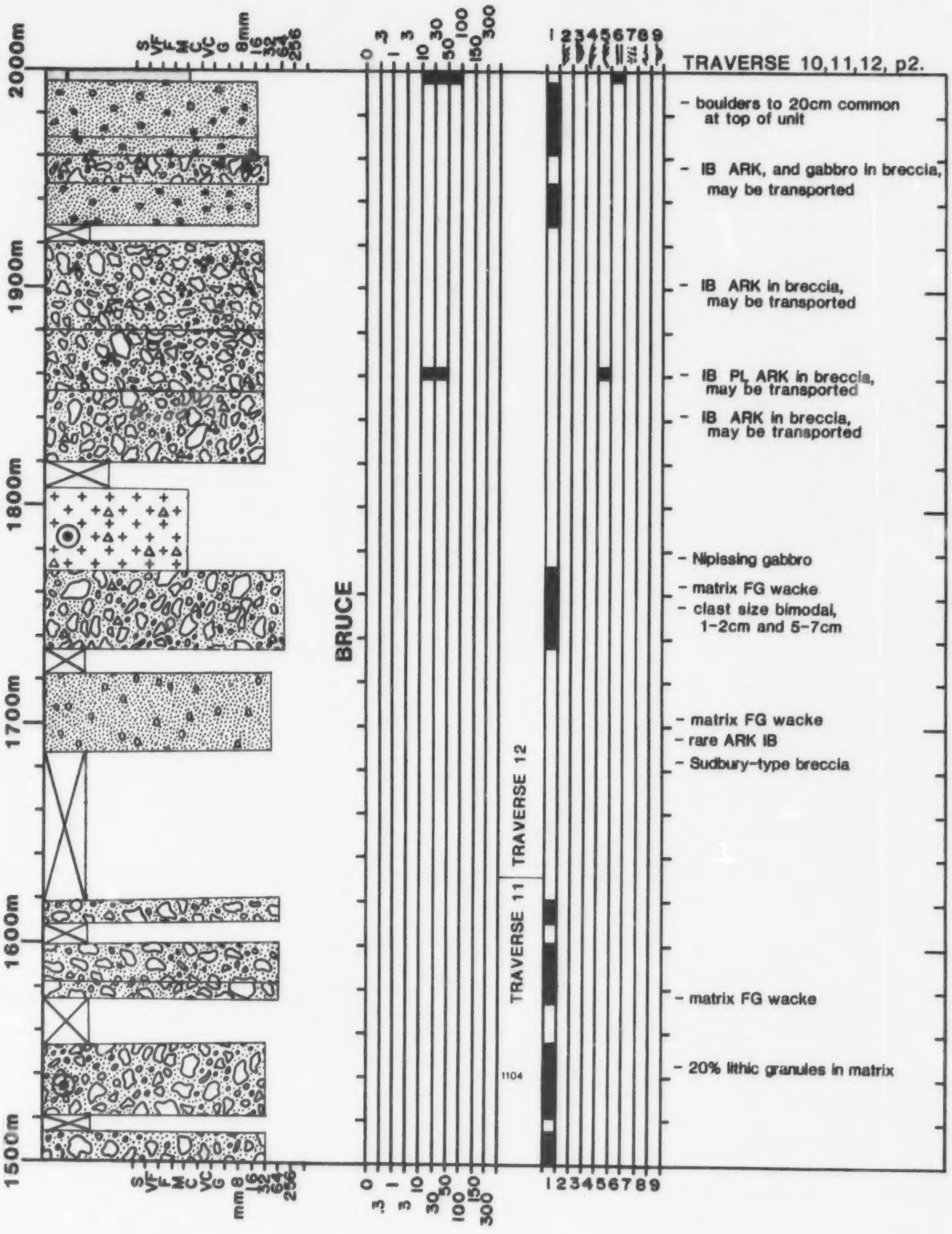

TRAVERSE 7, 8, 9, p.2
2000m
1900m
1800m
1700m
1600m
1500m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
TRAVERSE 9
TRAVERSE 8
0805
IB MG SUBARK and FG wacke
some BCS
IB MG SUBARK and FG wacke
SC MR in wacke to 5 cm
beds lenticular, BCS
some SC MR to 10cm
some beds lenticular
SC MR to 10 cm
DC IB FG SUBARK
monolithic Sudbury-type breccia
SC MR
some beds silty and/or FG


TRAVERSE 7, 8, 9, p.3
1500m
1400m
1300m
1200m
1100m
1000m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
TRAVERSE 8
0801
SC MR
olivine diabase
some beds lenticular
some BCS
silty, wacke, channel fill
beds lenticular, BCS
beds lenticular, BCS
DC IB FG wacke
trough a planar CB form cosets
DC IB FG wacke
beds lenticular
BCS
beds lenticular, BCS
IB FG wacke to 20 cm
some BCS
SC MR
strong cleavage
beds DC
BCS
DC IB FG wacke
IB FG wacke to 8 cm
IB FG wacke to 15 cm
IB FG wacke to 50 cm
some BCS


TRAVERSE 7, 8, 9, p.4
1000m
900m
800m
700m
600m
500m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
T-8
0703
MISSISSAGI
TRAVERSE 7
IB FG wacke to 50cm and MG SUBARK to 200cm
IB SLTST
SC MR
BCS
trough crossbeds form cosets with planar and dune cross-beds
planar and trough cross-beds form cosets
some BCS
some SC MR
SC MR
IB FG SUBARK
IB FG SUBARK
SC MR
BCS
BCS
IB FG SUBARK

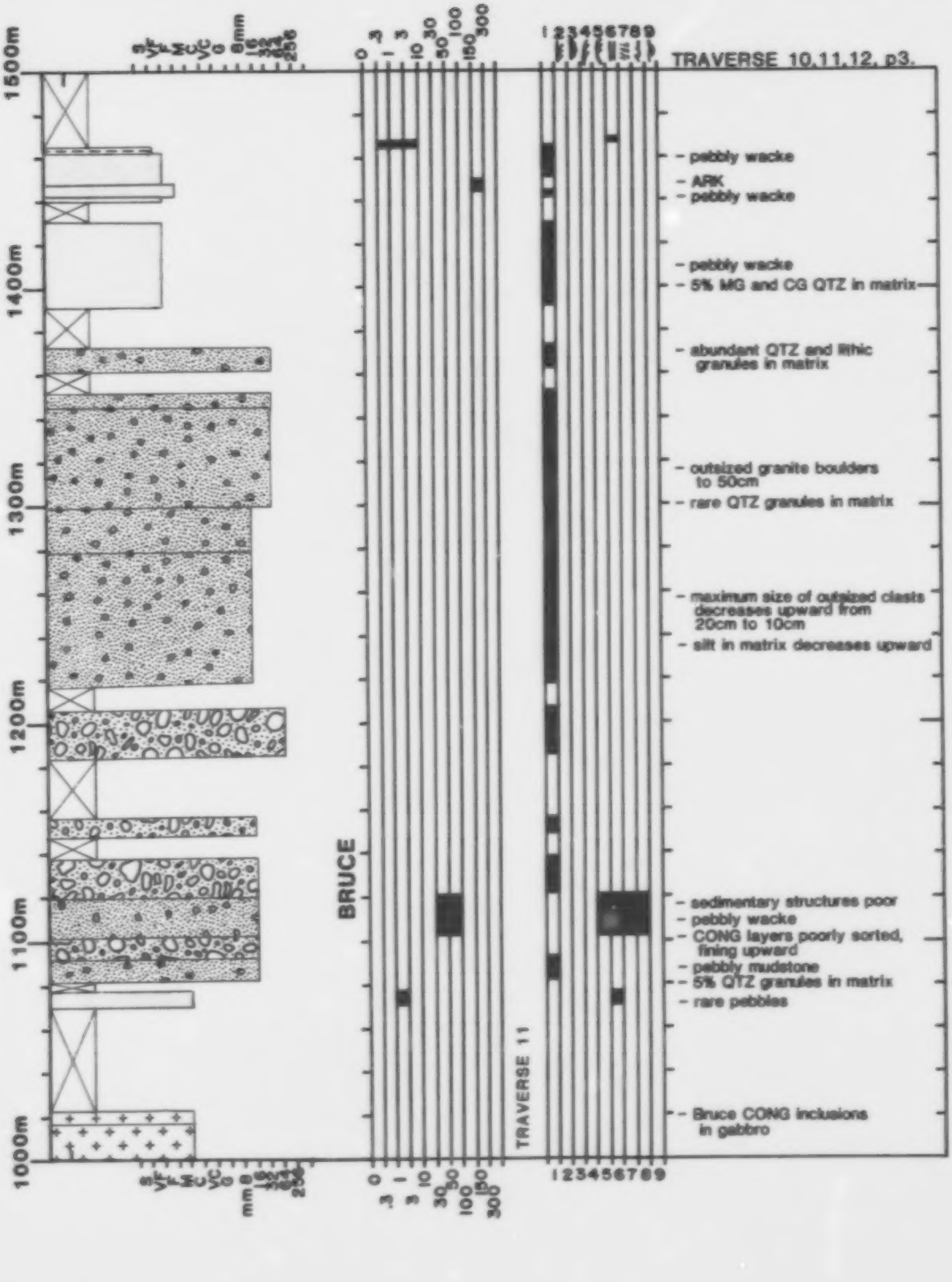

TRAVERSE 7, 8, 9, p.5
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
TRAVERSE 7
0701
- IB FG SUBARK
- DC IB FG SUBARK
- SC MR
- few FG IB
- DC FG IB
- DC FG IB
- some BCS
- SC MR
- SC MR
- cleavage strong
- SC MR 5 to 15cm
- few DC FG wacke IB
- SC MR to 10cm
- SC MR
- tops of some beds FG
S VF F M C VC G mm 8 16 32 64 256
0 .3 1 3 10 30 50 100 150 200
1 2 3 4 5 6 7 8 9

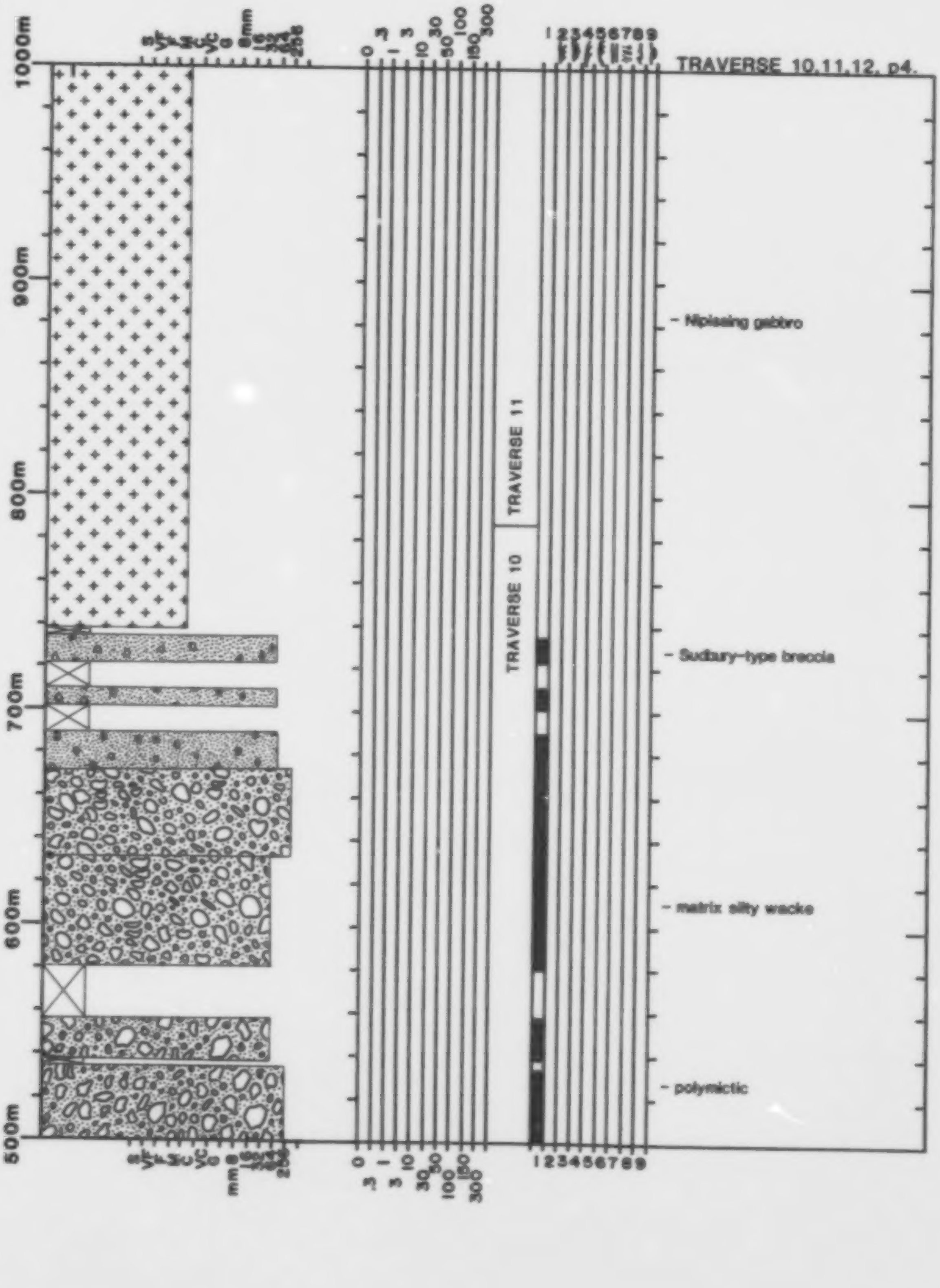

TRAVERSE 10,11,12, p1.
2500m
2400m
2300m
2200m
2100m
2000m
S
VF
F
M
C
VC
G
8mm
16
32
64
256
0
.3
1
3
10
30
50
100
150
300
1 2 3 4 5 6 7 8 9
NIPISSING
SERPENT
- Nipissing gabbro
- FG gabbro xenoliths
- Nipissing gabbro
- Nipissing gabbro
- ARK
- Nipissing gabbro
- PL poorly defined: highlighted by contact metamorphism
- ARK
- rare dropstones to 5cm

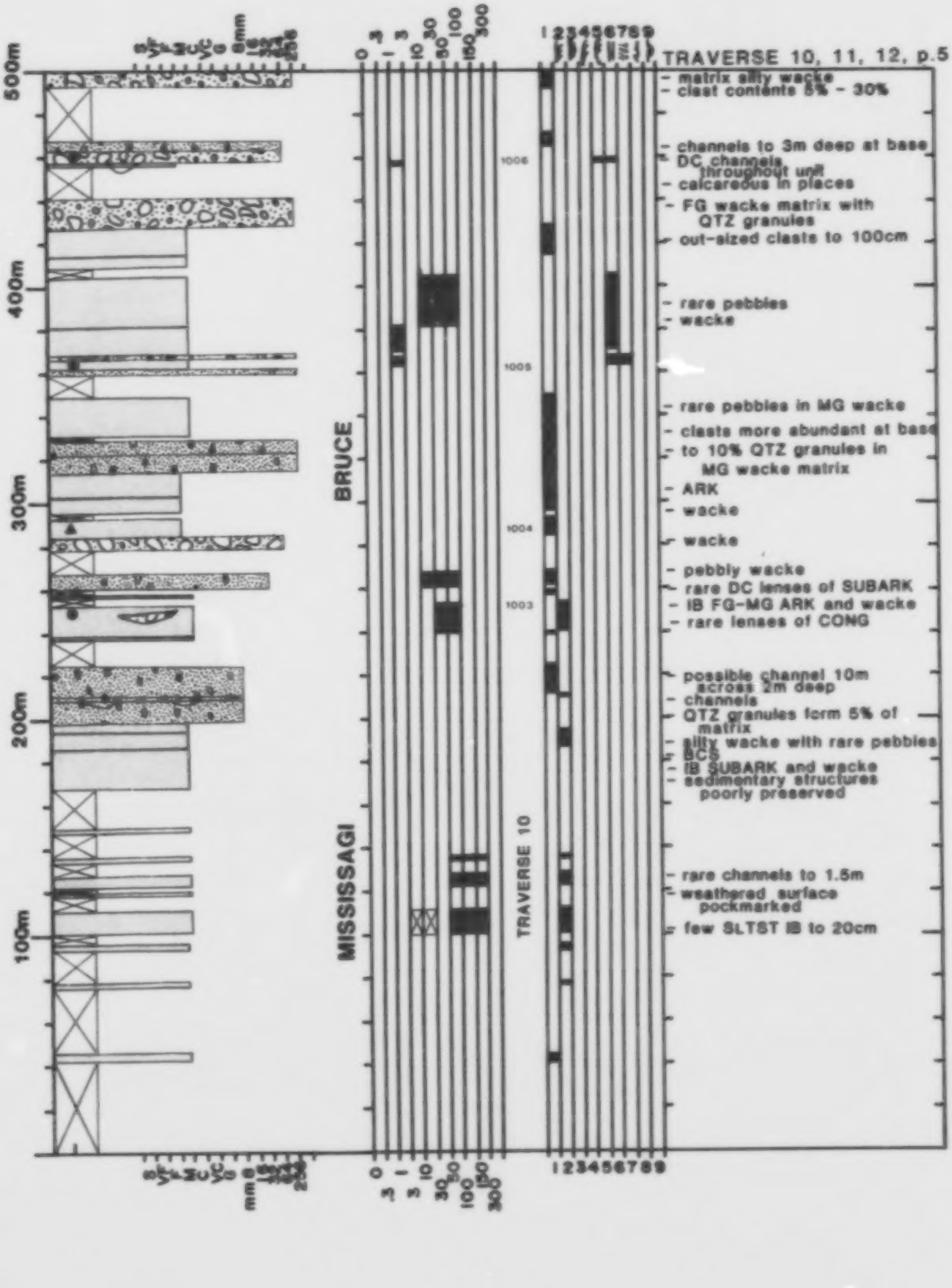


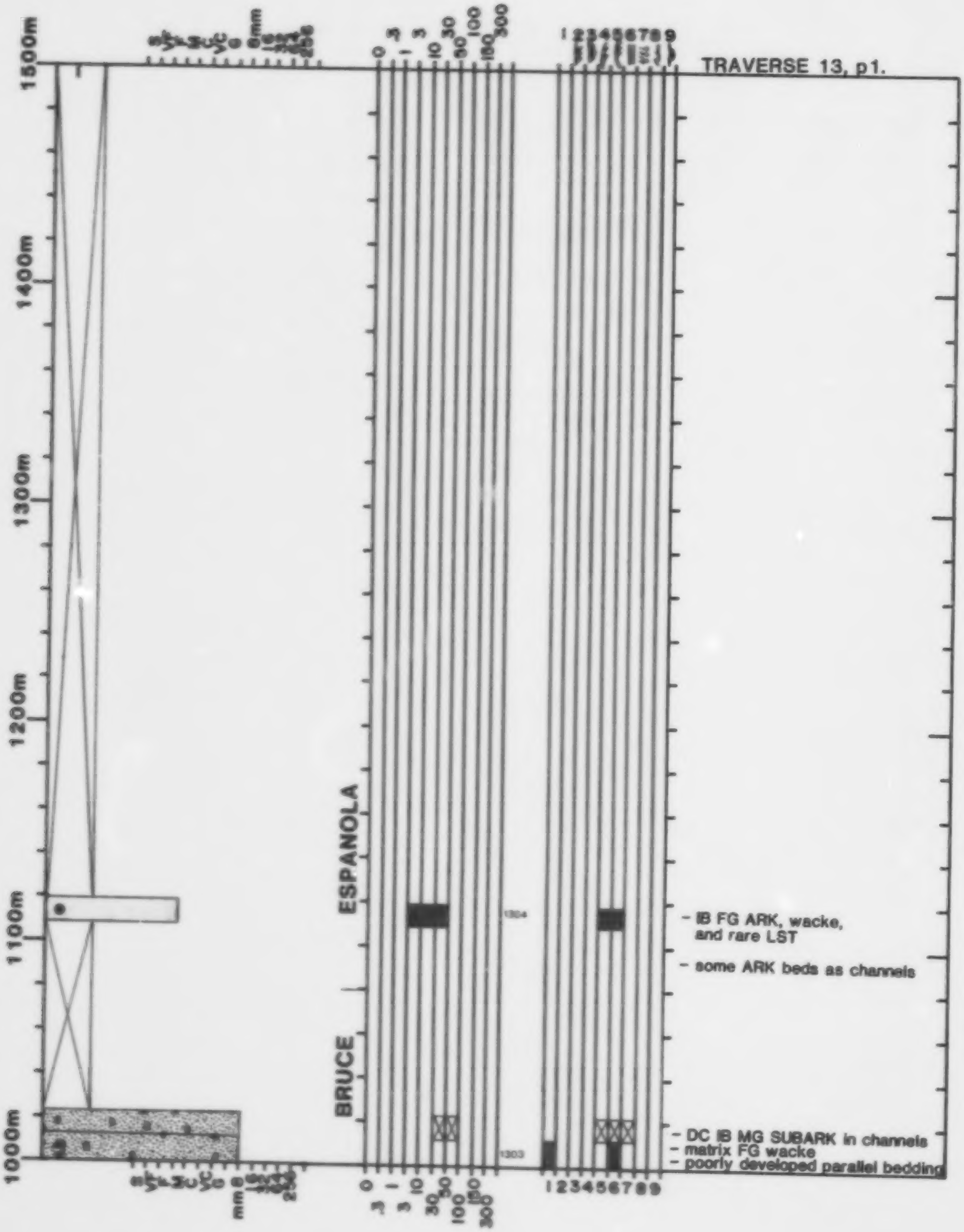
TRAVERSE 10,11,12, p2.

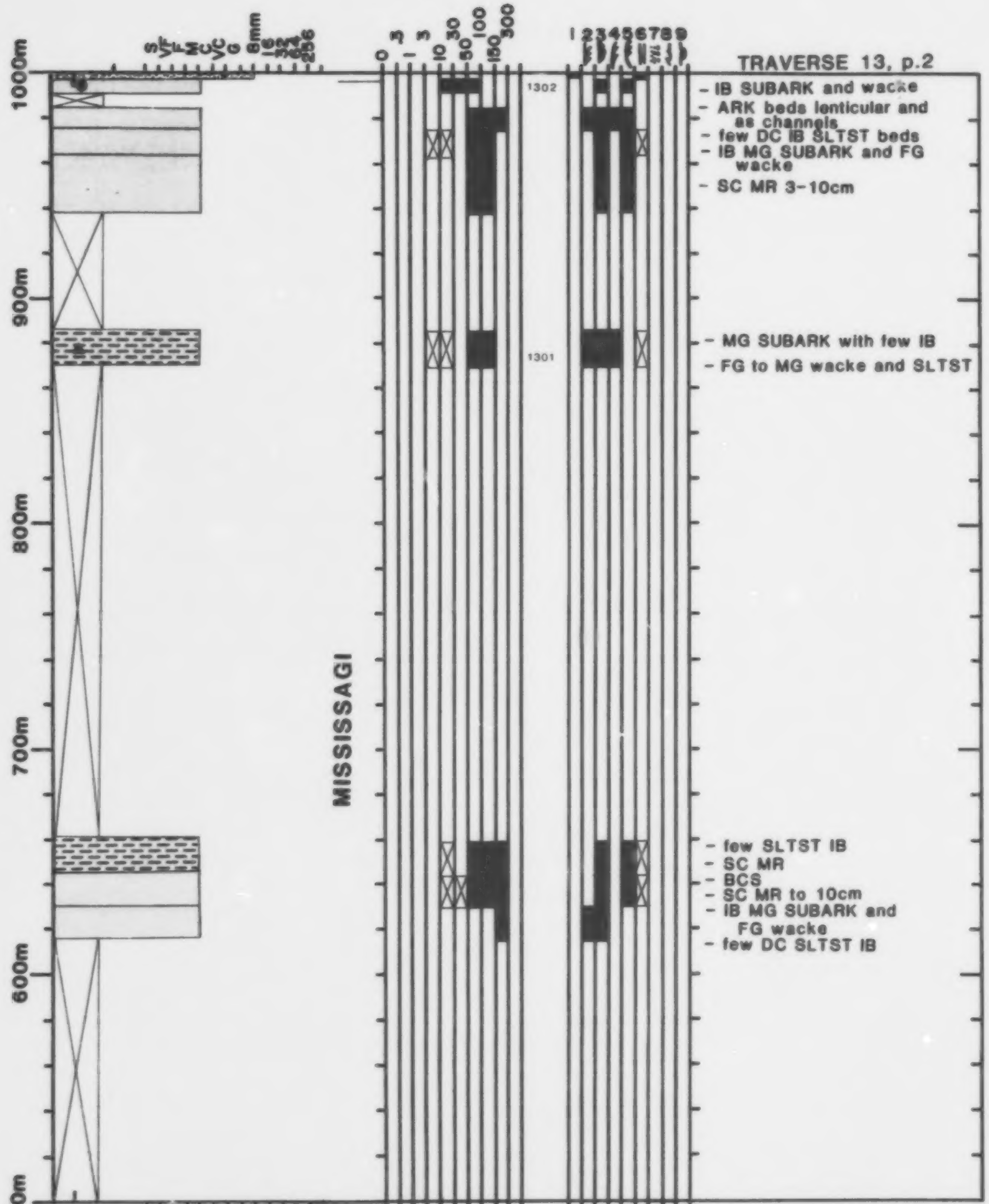
- boulders to 20cm common at top of unit
- IB ARK, and gabbro in breccia, may be transported
- IB ARK in breccia, may be transported
- IB PL ARK in breccia, may be transported
- IB ARK in breccia, may be transported
- Nipissing gabbro
- matrix FG wacke
- clast size bimodal, 1-2cm and 5-7cm
- matrix FG wacke
- rare ARK IB
- Sudbury-type breccia
- matrix FG wacke
- 20% lithic granules in matrix

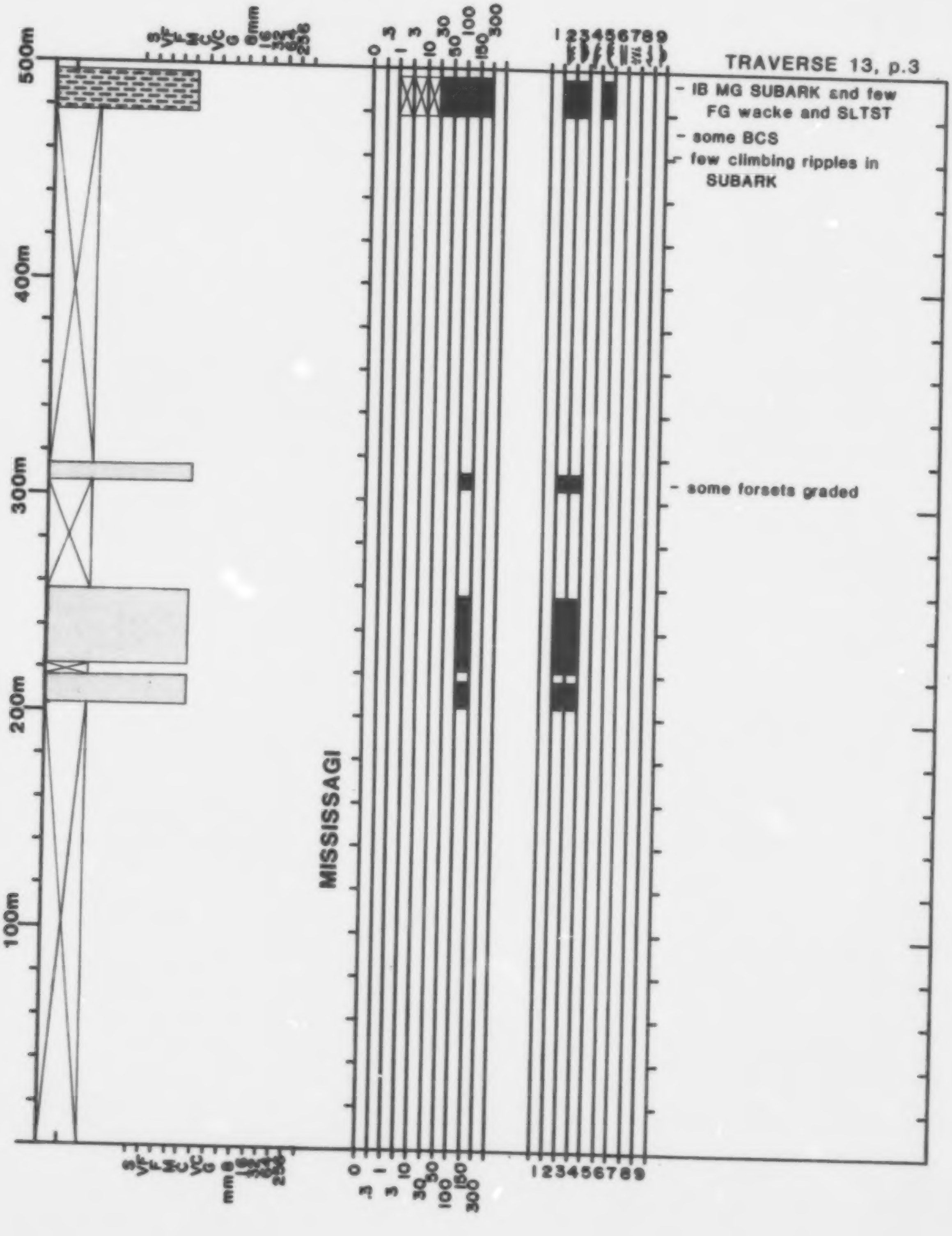

TRAVERSE 10,11,12, p3.
1500m
1400m
1300m
1200m
1100m
1000m
VF F M C VC G 8mm 256
0 .3 1 3 10 30 50 100 150 300
123456789
BRUCE
TRAVERSE 11
- pebbly wacke
- ARK
- pebbly wacke
- pebbly wacke
- 5% MG and CG QTZ in matrix
- abundant QTZ and lithic granules in matrix
- outsized granite boulders to 50cm
- rare QTZ granules in matrix
- maximum size of outsized clasts decreases upward from 20cm to 10cm
- silt in matrix decreases upward
- sedimentary structures poor
- pebbly wacke
- CONG layers poorly sorted, fining upward
- pebbly mudstone
- 5% QTZ granules in matrix
- rare pebbles
- Bruce CONG inclusions in gabbro

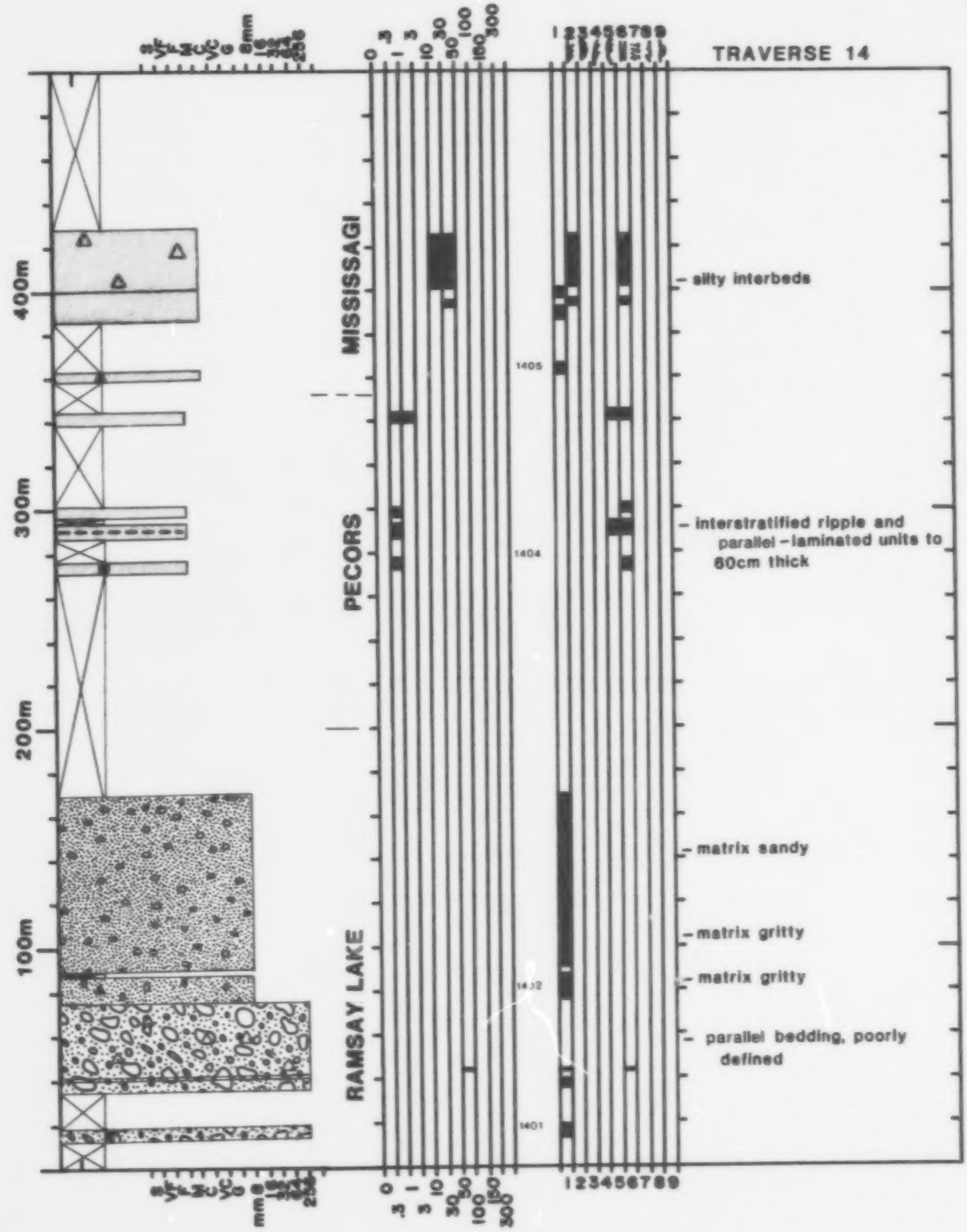

TRAVERSE 10,11,12, p4.
1000m
900m
800m
700m
600m
500m
sl vf f m c vc g
mm 8 16 32 64 128 256
0 .3 1 3 10 30 50 100 150 300
123456789
TRAVERSE 11
TRAVERSE 10
- Nipissing gabbro
- Sudbury-type breccia
- matrix silty wacke
- polymictic

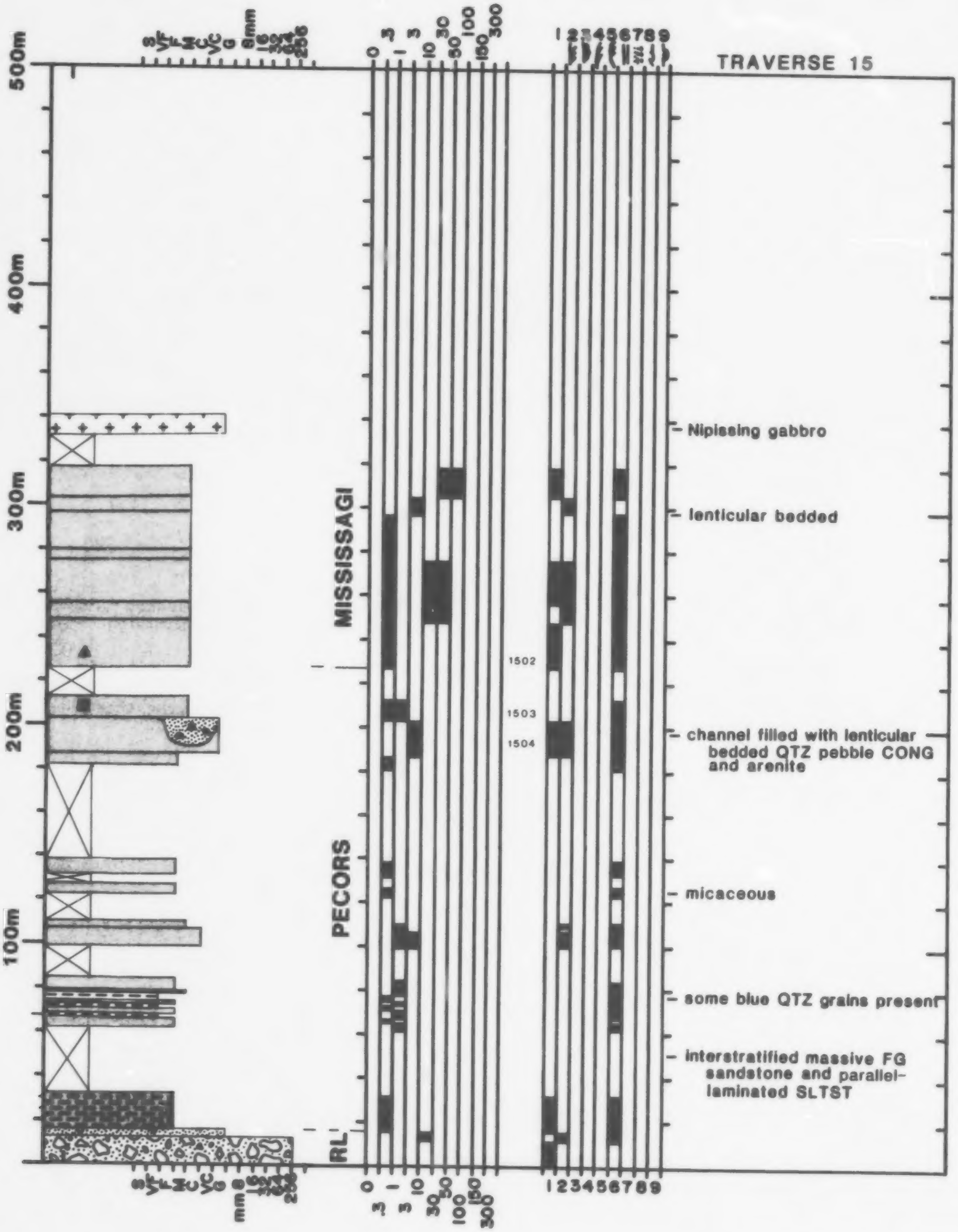

TRAVERSE 10, 11, 12, p.5
500m
400m
300m
200m
100m
mm
0
.5
1
5
10
30
50
100
150
300
1 2 3 4 5 6 7 8 9
BRUCE
MISSISSAGI
TRAVERSE 10
1006
1005
1004
1003
- matrix silty wacke
- clast contents 5% - 30%
- channels to 3m deep at base
- DC channels throughout unit
- calcareous in places
- FG wacke matrix with QTZ granules
- out-sized clasts to 100cm
- rare pebbles
- wacke
- rare pebbles in MG wacke
- clasts more abundant at base
- to 10% QTZ granules in MG wacke matrix
- ARK
- wacke
- wacke
- pebbly wacke
- rare DC lenses of SUBARK
- IB FG-MG ARK and wacke
- rare lenses of CONG
- possible channel 10m across 2m deep
- channels
- QTZ granules form 5% of matrix
- silty wacke with rare pebbles
- BCS
- IB SUBARK and wacke
- sedimentary structures poorly preserved
- rare channels to 1.5m
- weathered surface pockmarked
- few SLTST IB to 20cm

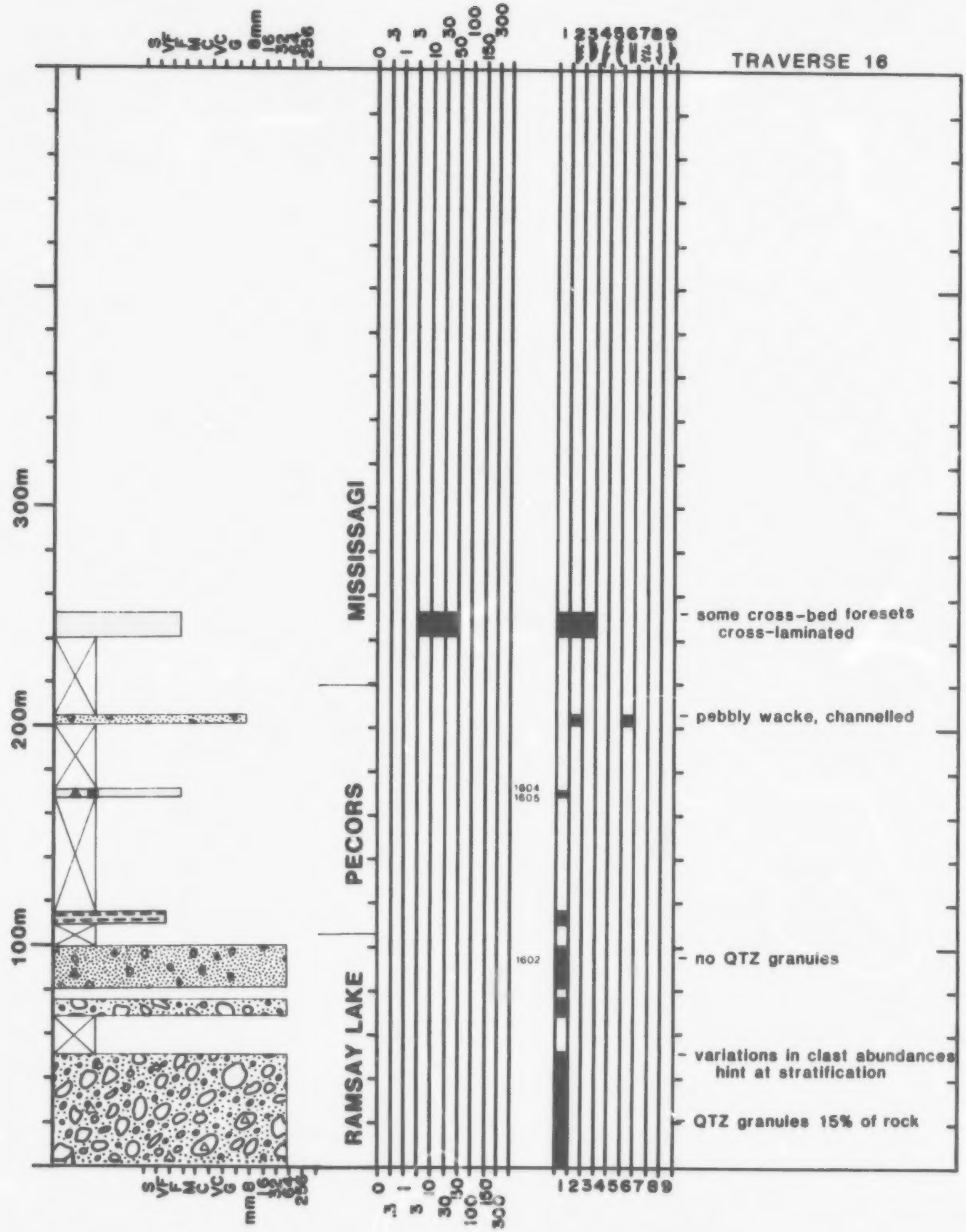

TRAVERSE 13, p1.
1500m
1400m
1300m
1200m
1100m
1000m
ESPANOLA
BRUCE
0 .5 1 3 5 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
mm
256
1304
1303
- IB FG ARK, wacke, and rare LST
- some ARK beds as channels
- DC IB MG SUBARK in channels
- matrix FG wacke
- poorly developed parallel bedding

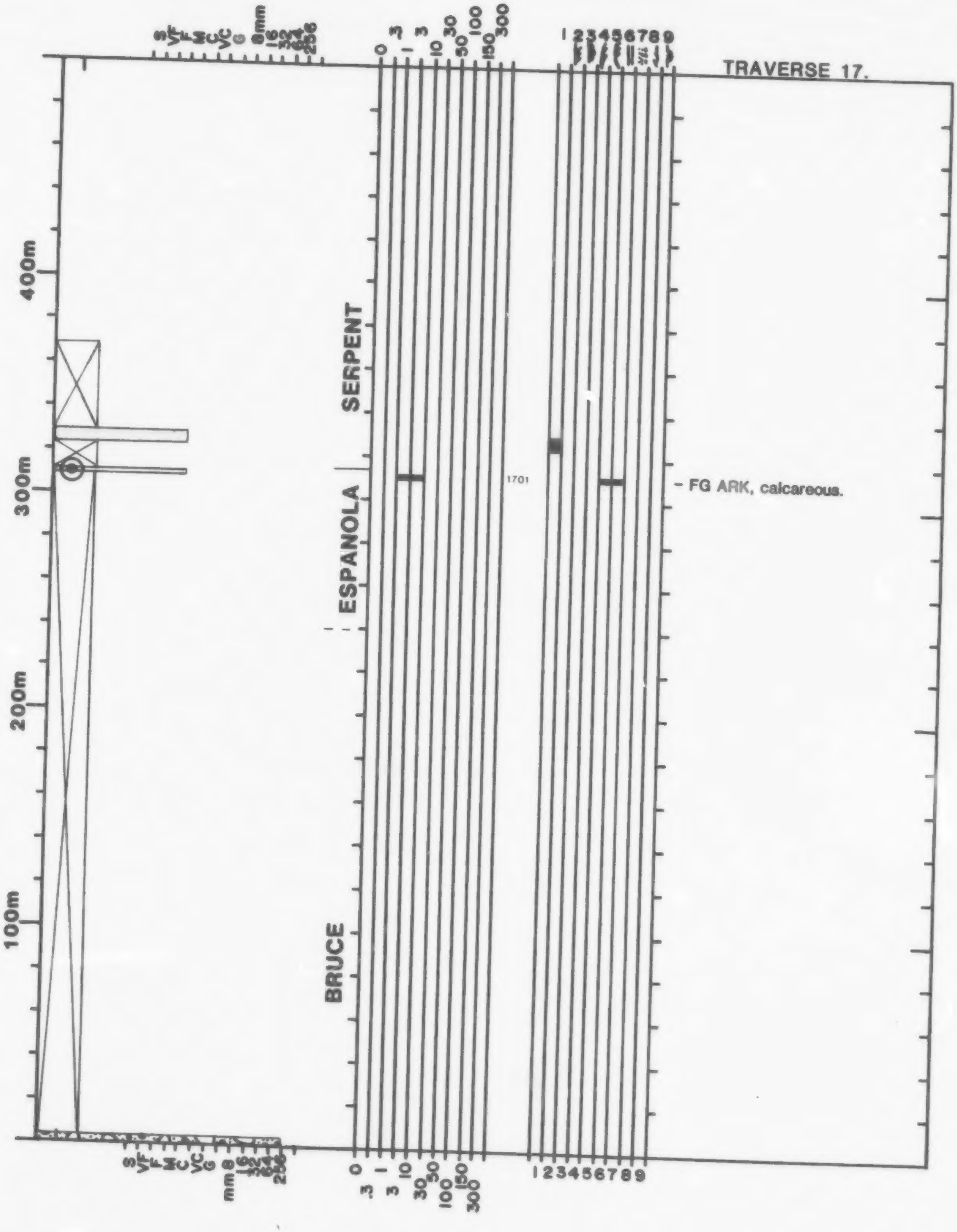

TRAVERSE 13, p.2
1000m
900m
800m
700m
600m
500m
S
VF
F
M
C
VC
G
8mm
16
32
64
256
0
.3
1
3
10
30
50
100
150
300
1302
1301
123456789
MISSISSAGI
- IB SUBARK and wacke
- ARK beds lenticular and as channels
- few DC IB SLTST beds
- IB MG SUBARK and FG wacke
- SC MR 3-10cm
- MG SUBARK with few IB
- FG to MG wacke and SLTST
- few SLTST IB
- SC MR
- BCS
- SC MR to 10cm
- IB MG SUBARK and FG wacke
- few DC SLTST IB


TRAVERSE 13, p.3
- IB MG SUBARK and few FG wacke and SLTST
- some BCS
- few climbing ripples in SUBARK
- some forsets graded
MISSISSAGI
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9

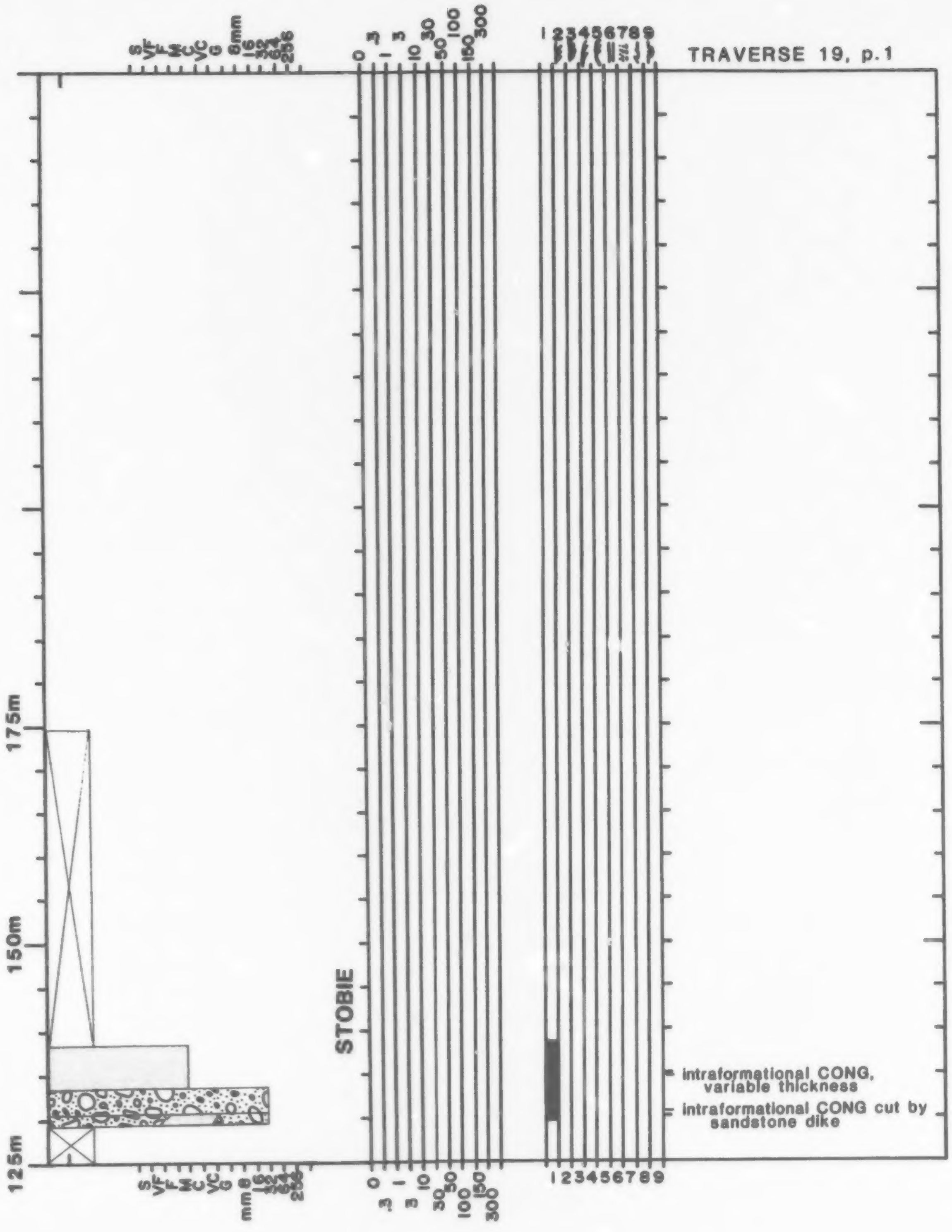

TRAVERSE 14
400m
300m
200m
100m
MISSISSAGI
PECORS
RAMSAY LAKE
silt VF F M C VC G 8mm 16 32 64 128 256
0 .5 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
1405
1404
1402
1401
silty interbeds
interstratified ripple and parallel-laminated units to 60cm thick
matrix sandy
matrix gritty
matrix gritty
parallel bedding, poorly defined

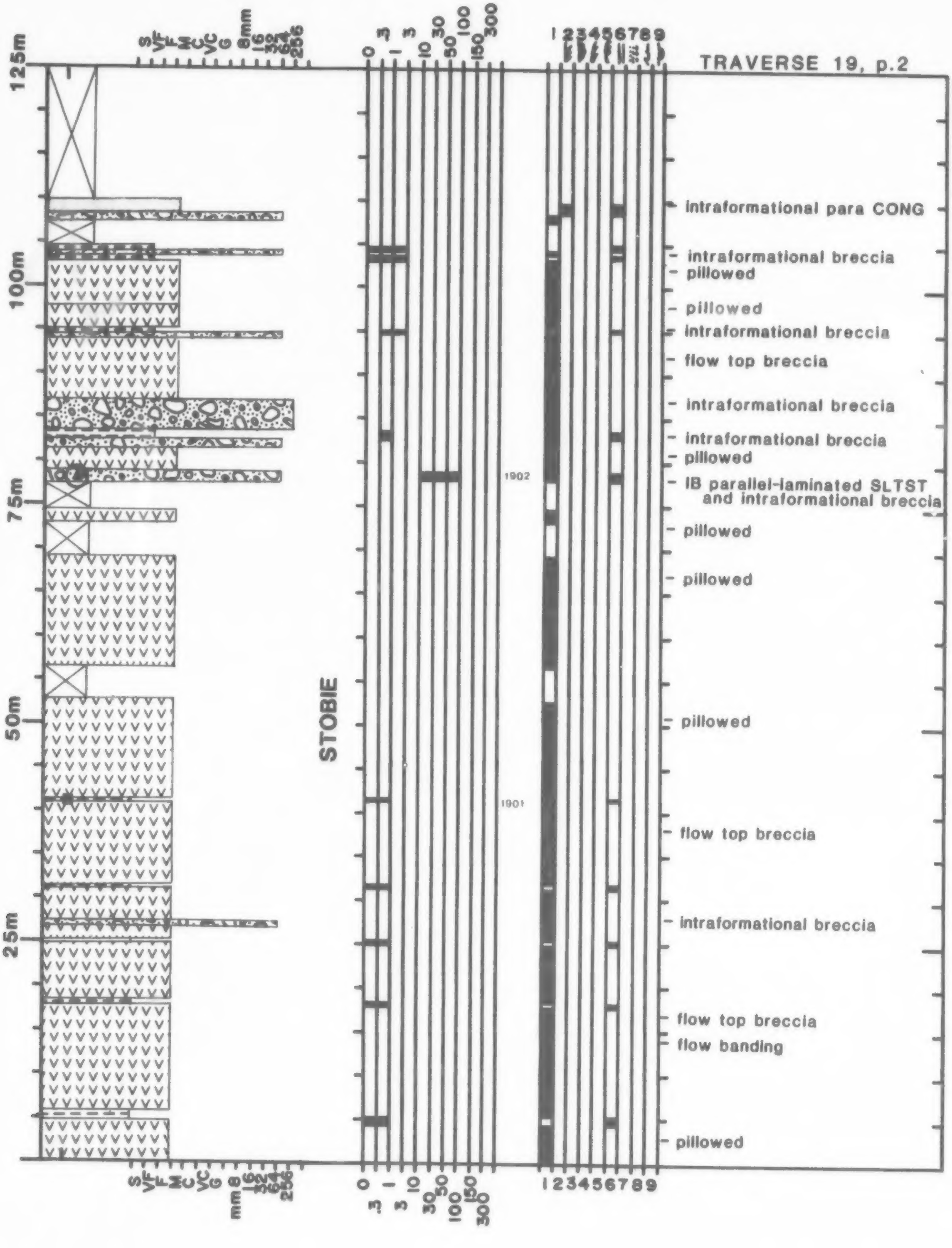

TRAVERSE 15
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
PECORS
RL
1502
1503
1504
Nipissing gabbro
lenticular bedded
channel filled with lenticular bedded QTZ pebble CONG and arenite
micaceous
some blue QTZ grains present
interstratified massive FG sandstone and parallel-laminated SLTST

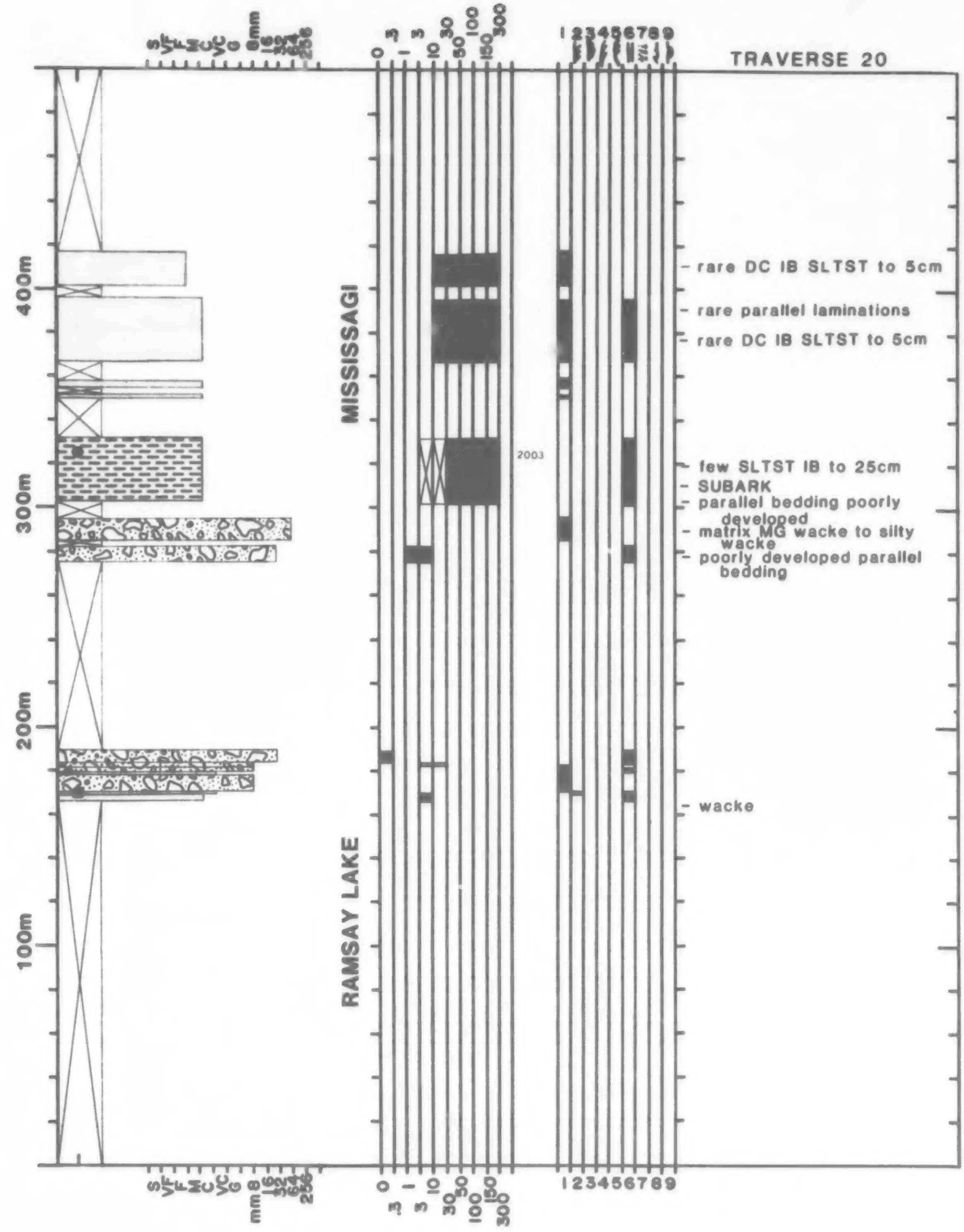

TRAVERSE 16
S
VF
F
M
C
VC
G
8mm
16
32
64
256
0
.3
1
3
10
30
50
100
150
300
1 2 3 4 5 6 7 8 9
300m
200m
100m
MISSISSAGI
PECORS
RAMSAY LAKE
1604
1605
1602
some cross-bed foresets cross-laminated
pebbly wacke, channelled
no QTZ granules
variations in clast abundances hint at stratification
QTZ granules 15% of rock

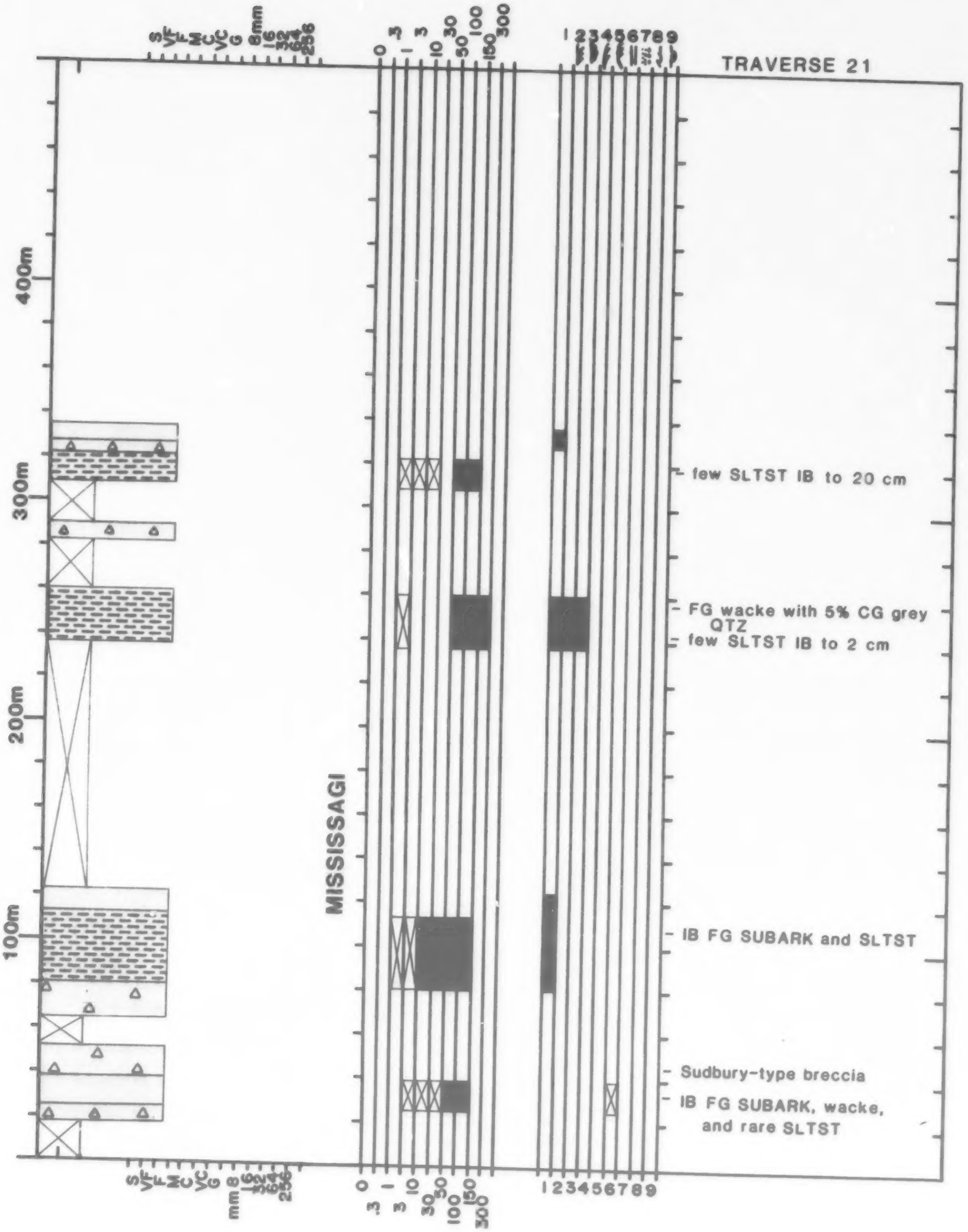


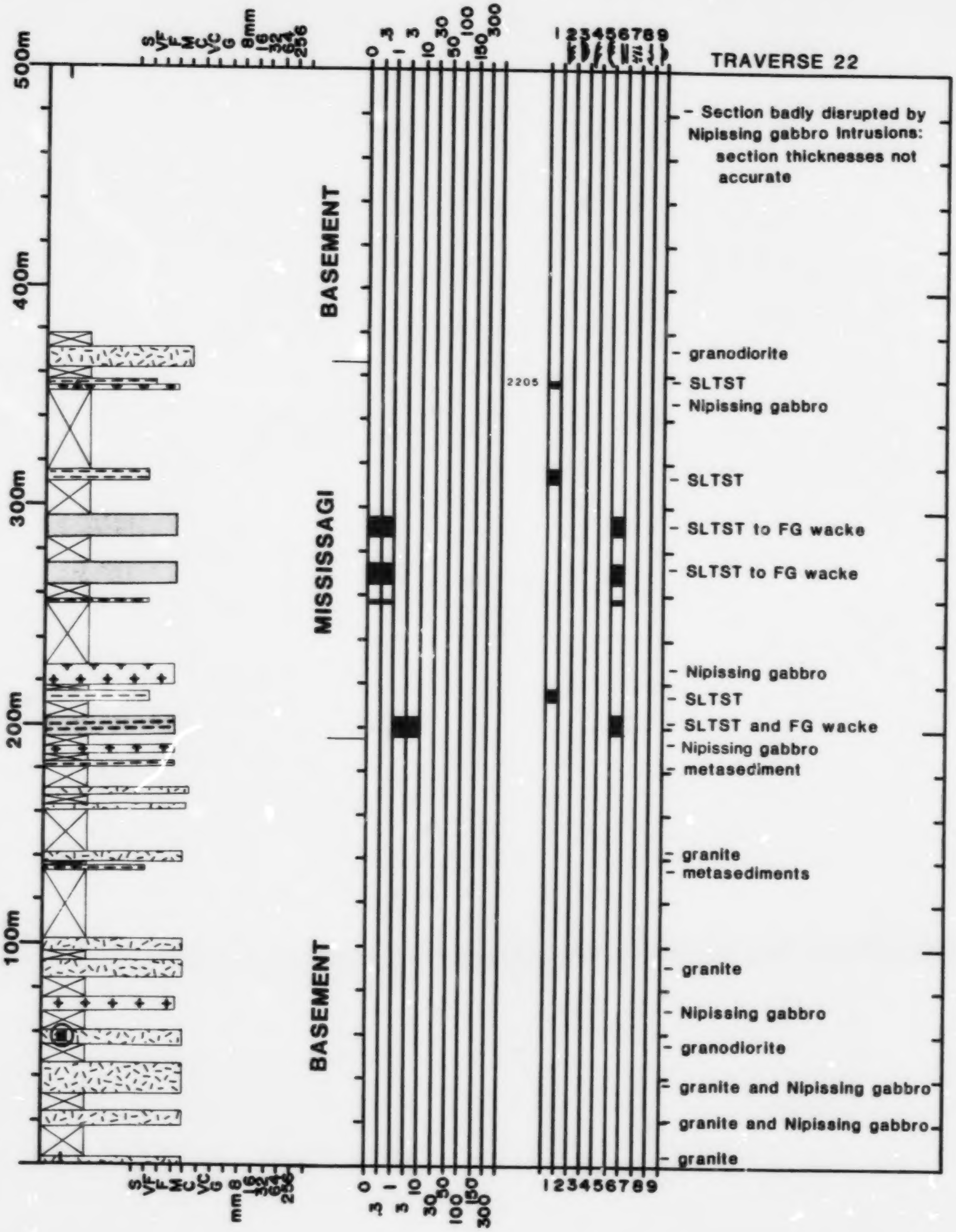
- FG ARK, calcareous.

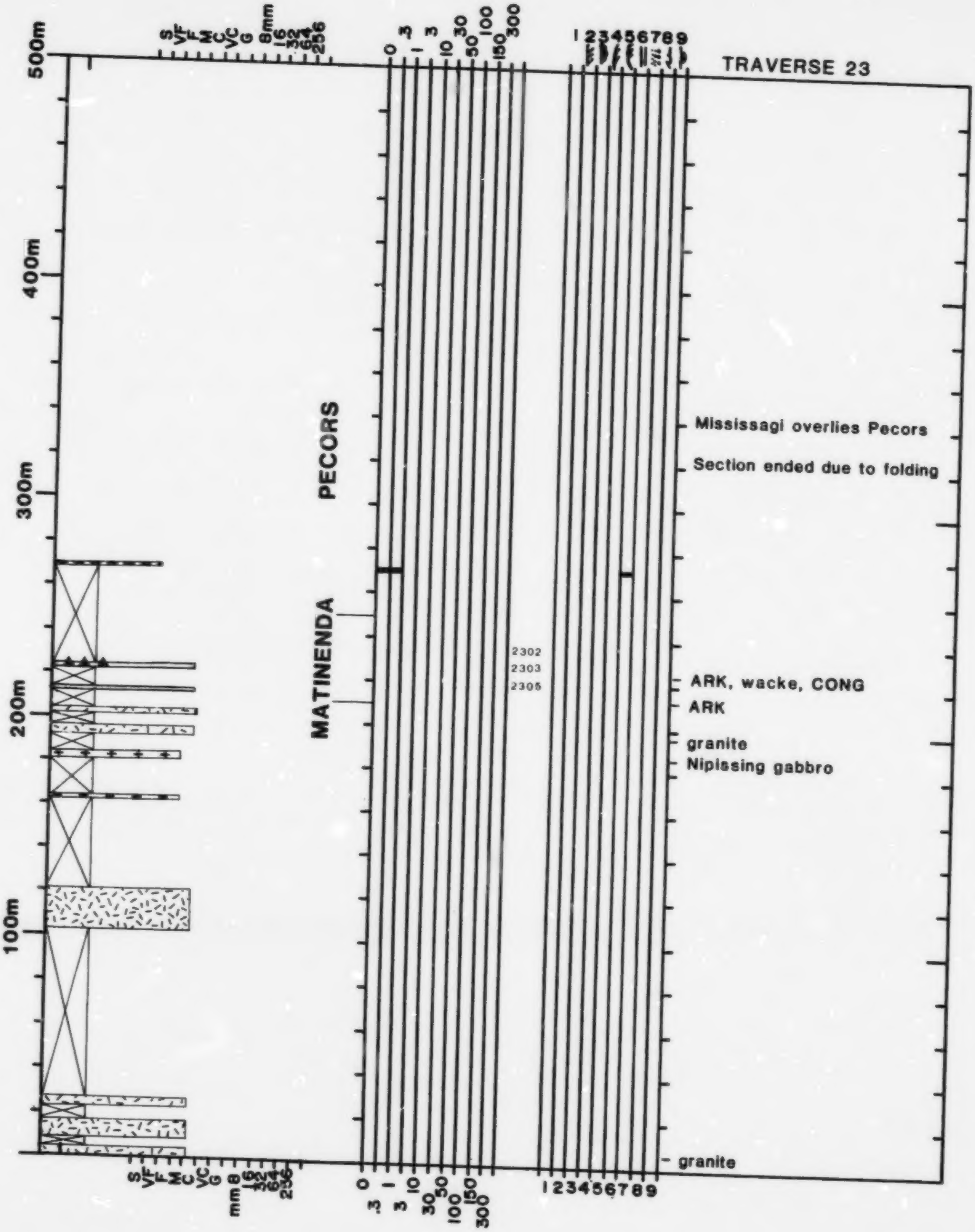

TRAVERSE 19, p.1
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
175m
150m
125m
STOBIE
intraformational CONG, variable thickness
intraformational CONG cut by sandstone dike

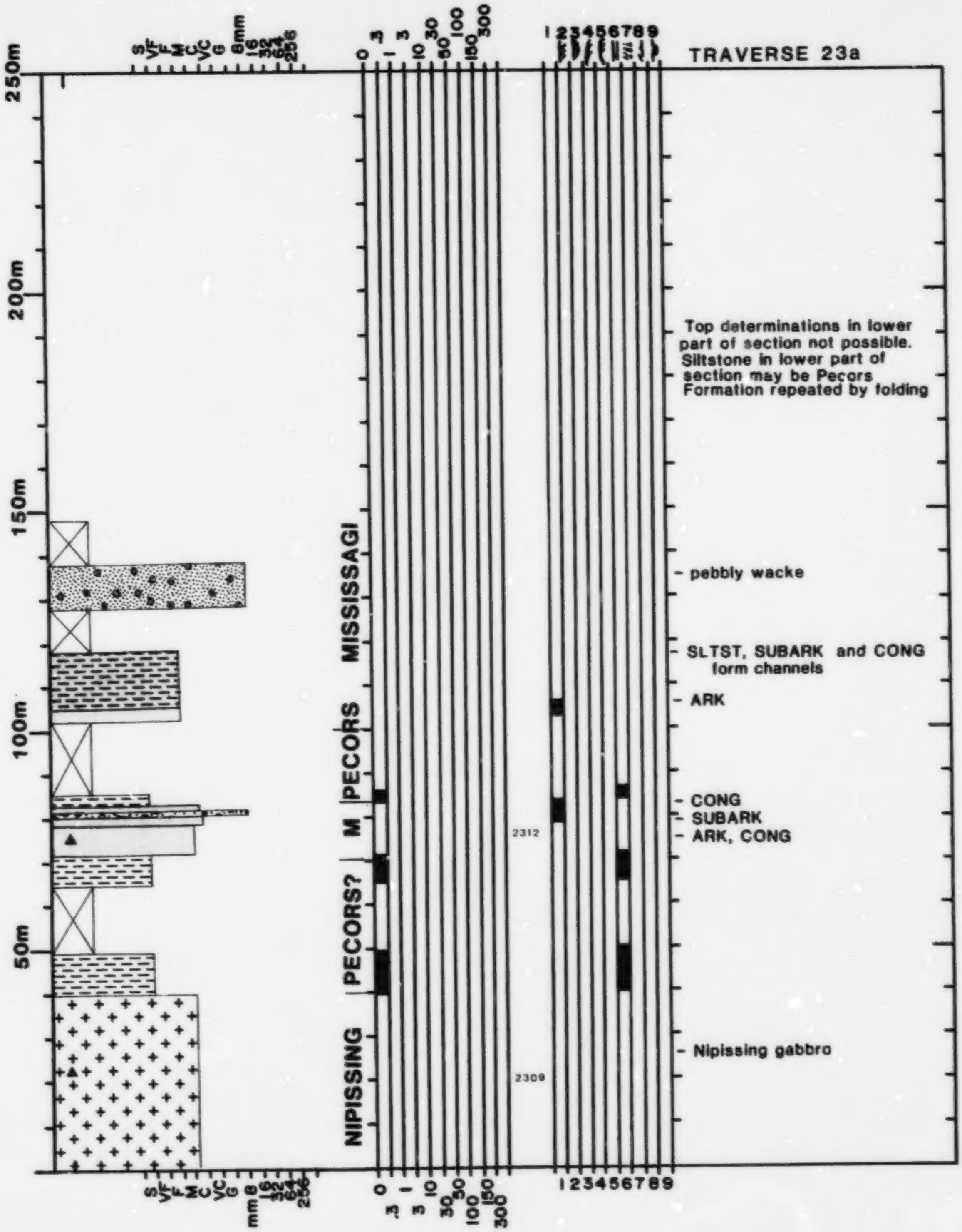

TRAVERSE 19, p.2
125m
100m
75m
50m
25m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
STOBIE
1902
1901
intraformational para CONG
intraformational breccia
pillowed
pillowed
intraformational breccia
flow top breccia
intraformational breccia
intraformational breccia
pillowed
IB parallel-laminated SLTST and intraformational breccia
pillowed
pillowed
pillowed
flow top breccia
intraformational breccia
flow top breccia
flow banding
pillowed

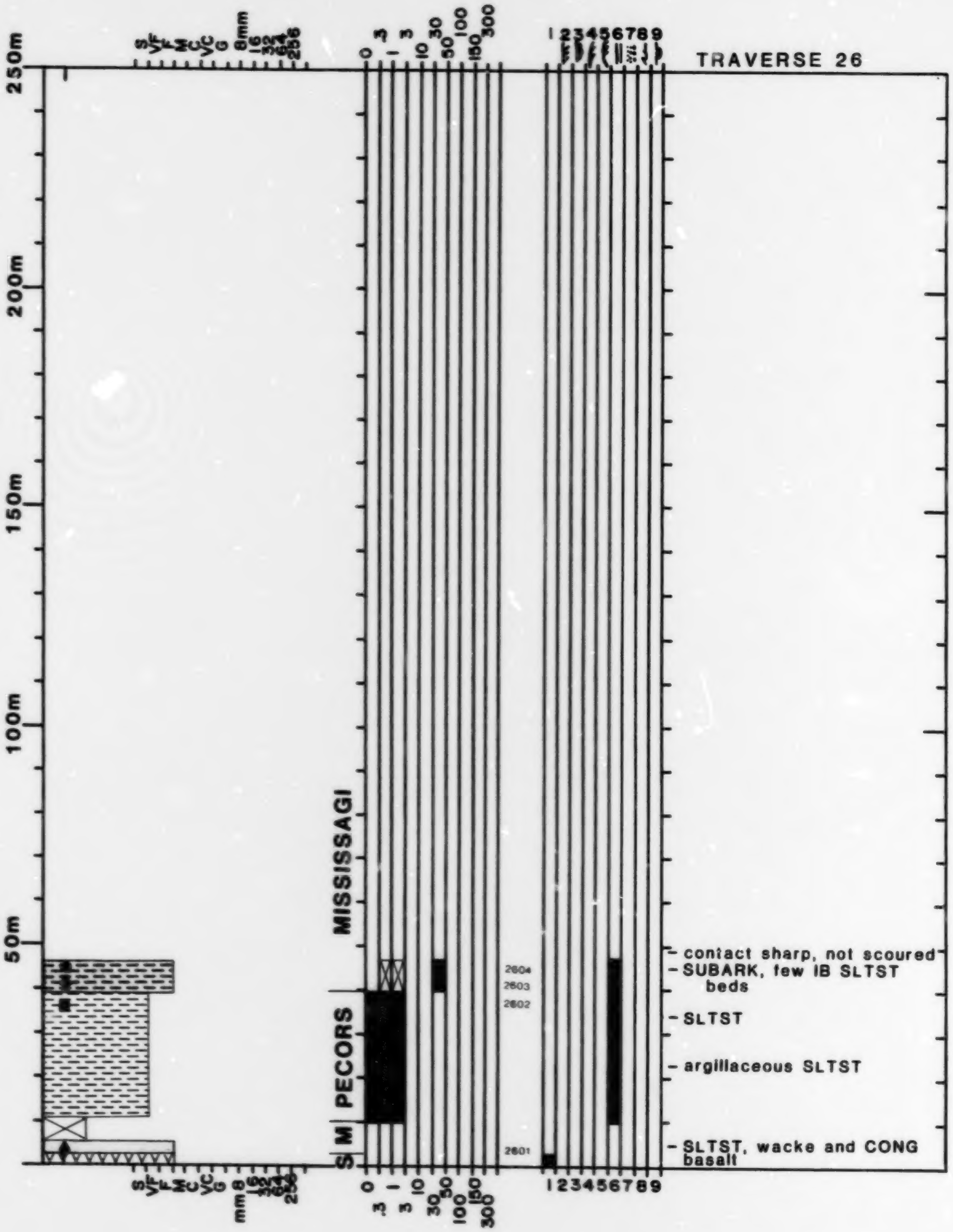

TRAVERSE 20
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
MISSISSAGI
RAMSAY LAKE
2003
rare DC IB SLTST to 5cm
rare parallel laminations
rare DC IB SLTST to 5cm
few SLTST IB to 25cm
SUBARK
parallel bedding poorly developed
matrix MG wacke to silty wacke
poorly developed parallel bedding
wacke

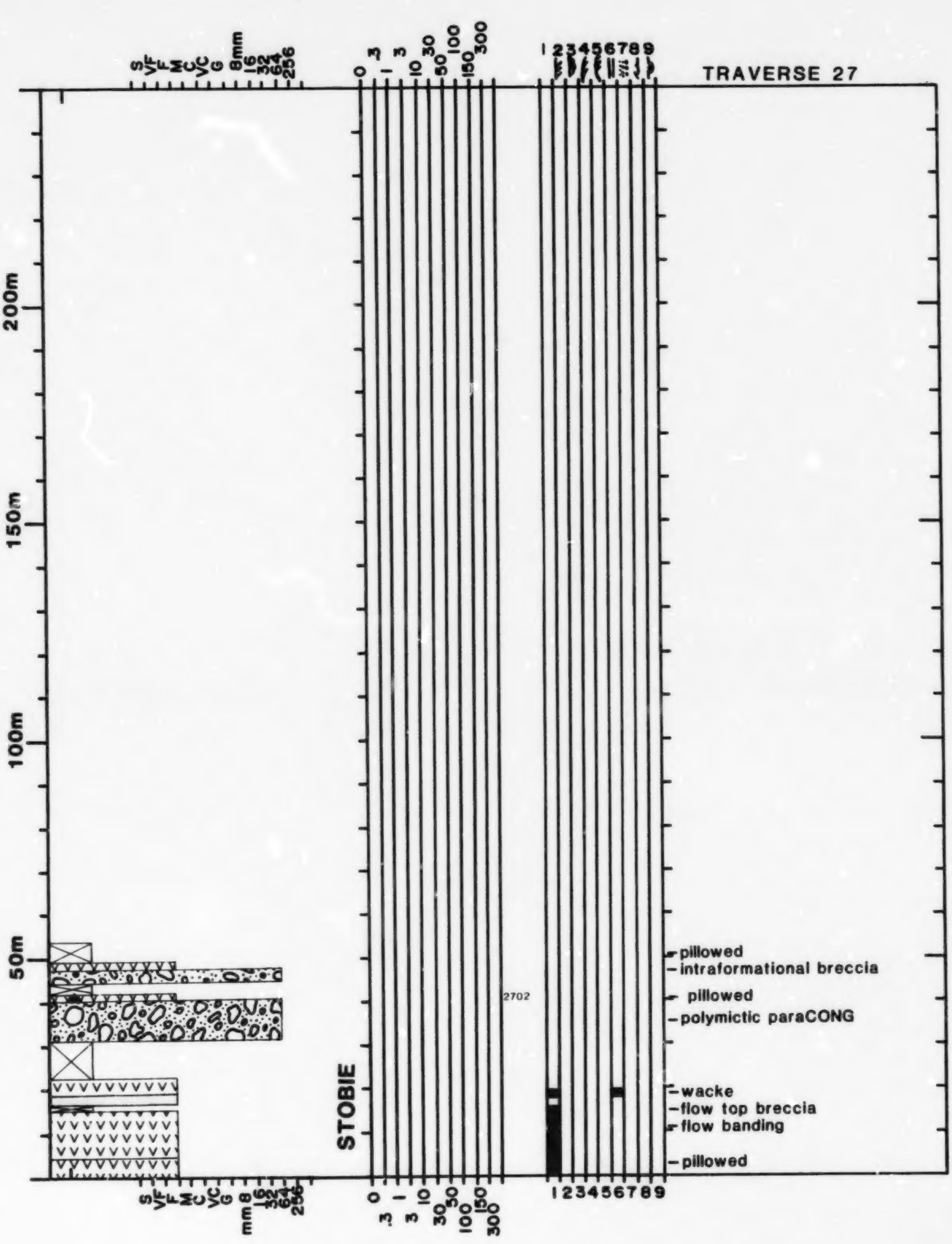

TRAVERSE 21
S VF F M C VC G 8mm 16 32 64 256
0 .3 .5 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
MISSISSAGI
few SLTST IB to 20 cm
FG wacke with 5% CG grey QTZ
few SLTST IB to 2 cm
IB FG SUBARK and SLTST
Sudbury-type breccia
IB FG SUBARK, wacke, and rare SLTST

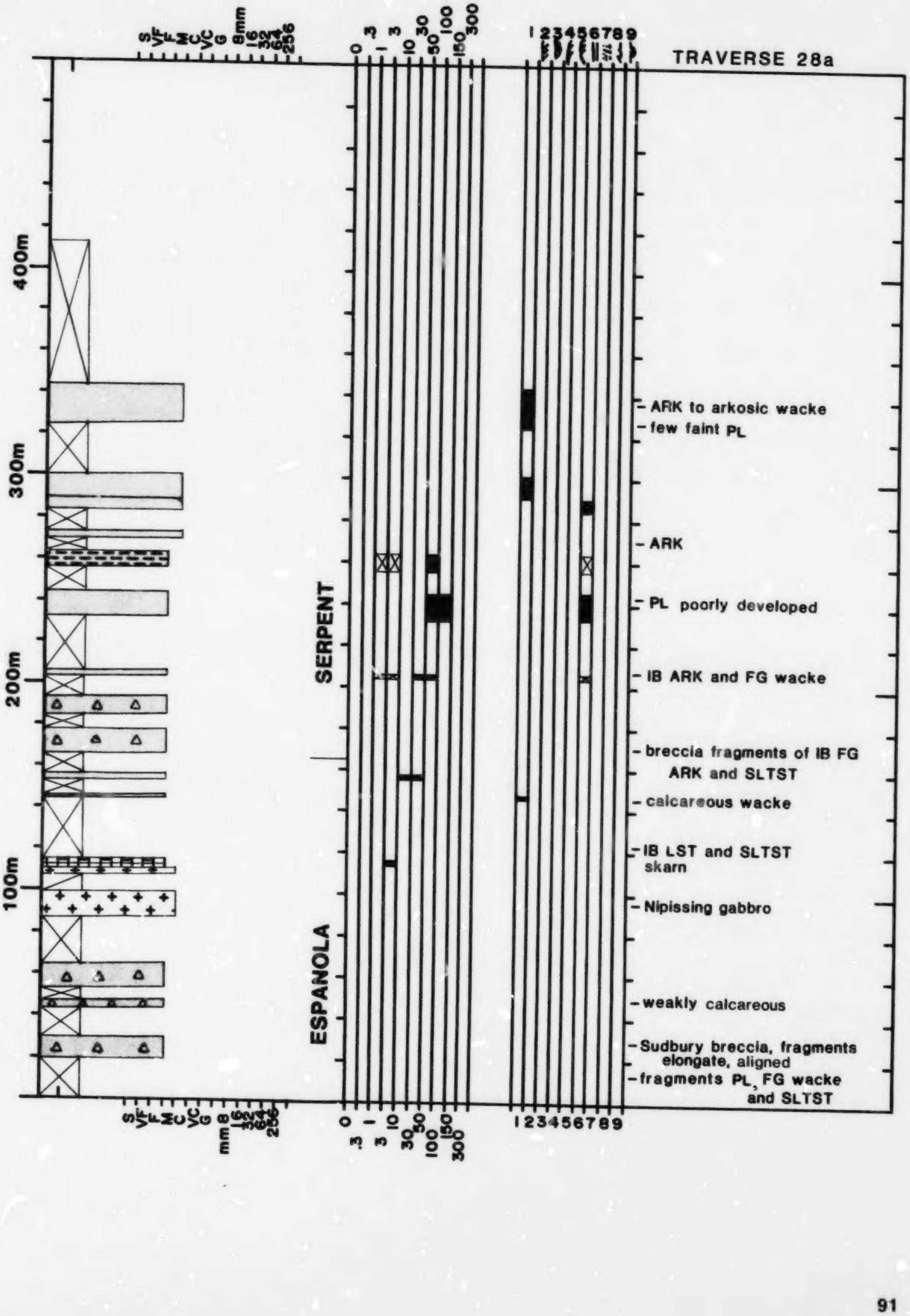

TRAVERSE 22
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
BASEMENT
MISSISSAGI
BASEMENT
2205
- Section badly disrupted by Nipissing gabbro intrusions: section thicknesses not accurate
- granodiorite
- SLTST
- Nipissing gabbro
- SLTST
- SLTST to FG wacke
- SLTST to FG wacke
- Nipissing gabbro
- SLTST
- SLTST and FG wacke
- Nipissing gabbro
- metasediment
- granite
- metasediments
- granite
- Nipissing gabbro
- granodiorite
- granite and Nipissing gabbro
- granite and Nipissing gabbro
- granite

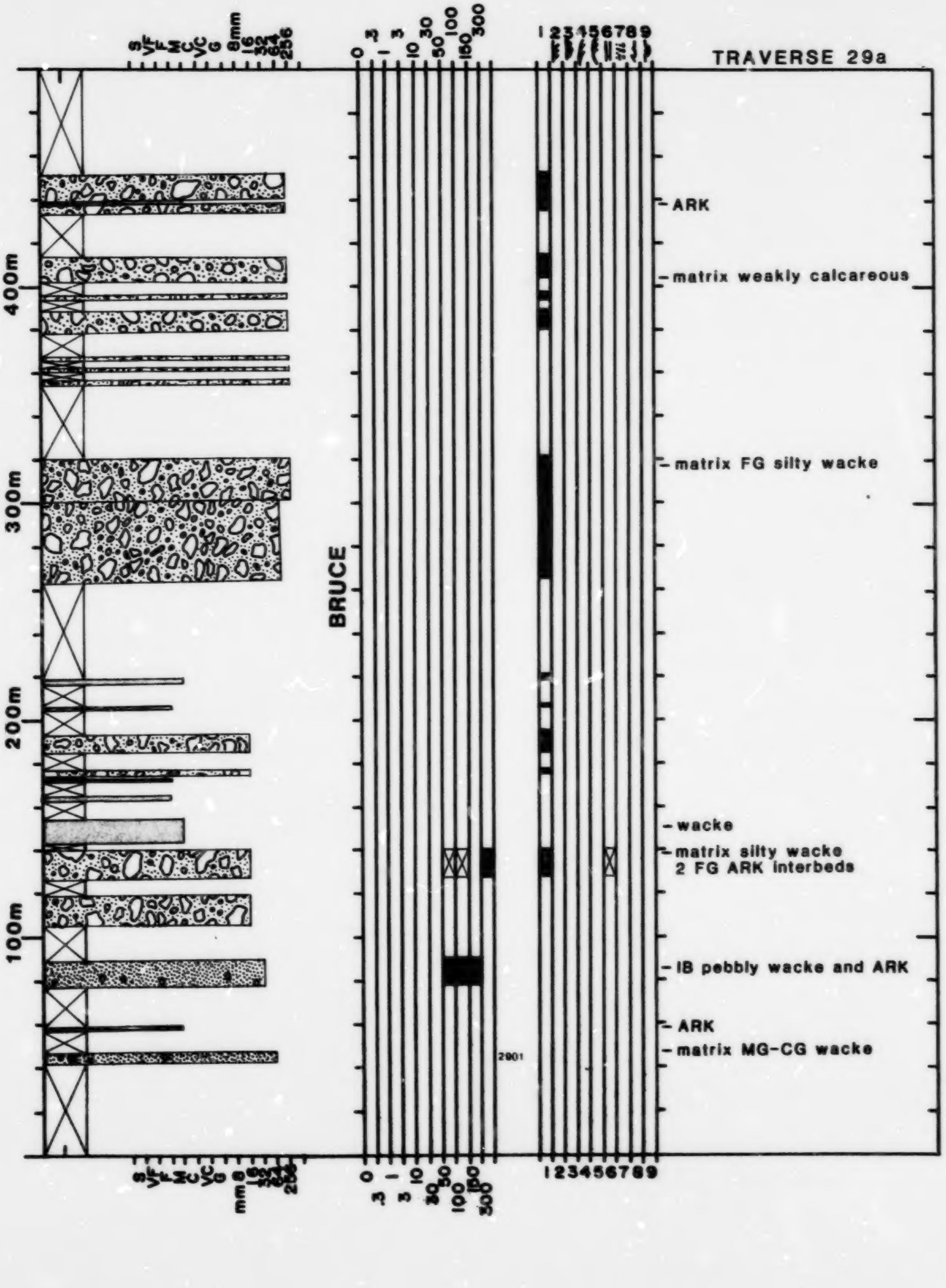

TRAVERSE 23
500m
400m
300m
200m
100m
S
VF
F
M
C
VC
G
8mm
16
32
64
256
0
.3
1
3
10
30
50
100
150
300
123456789
PECORS
MATINENDA
2302
2303
2305
Mississagi overlies Pecors
Section ended due to folding
ARK, wacke, CONG
ARK
granite
Nipissing gabbro
granite

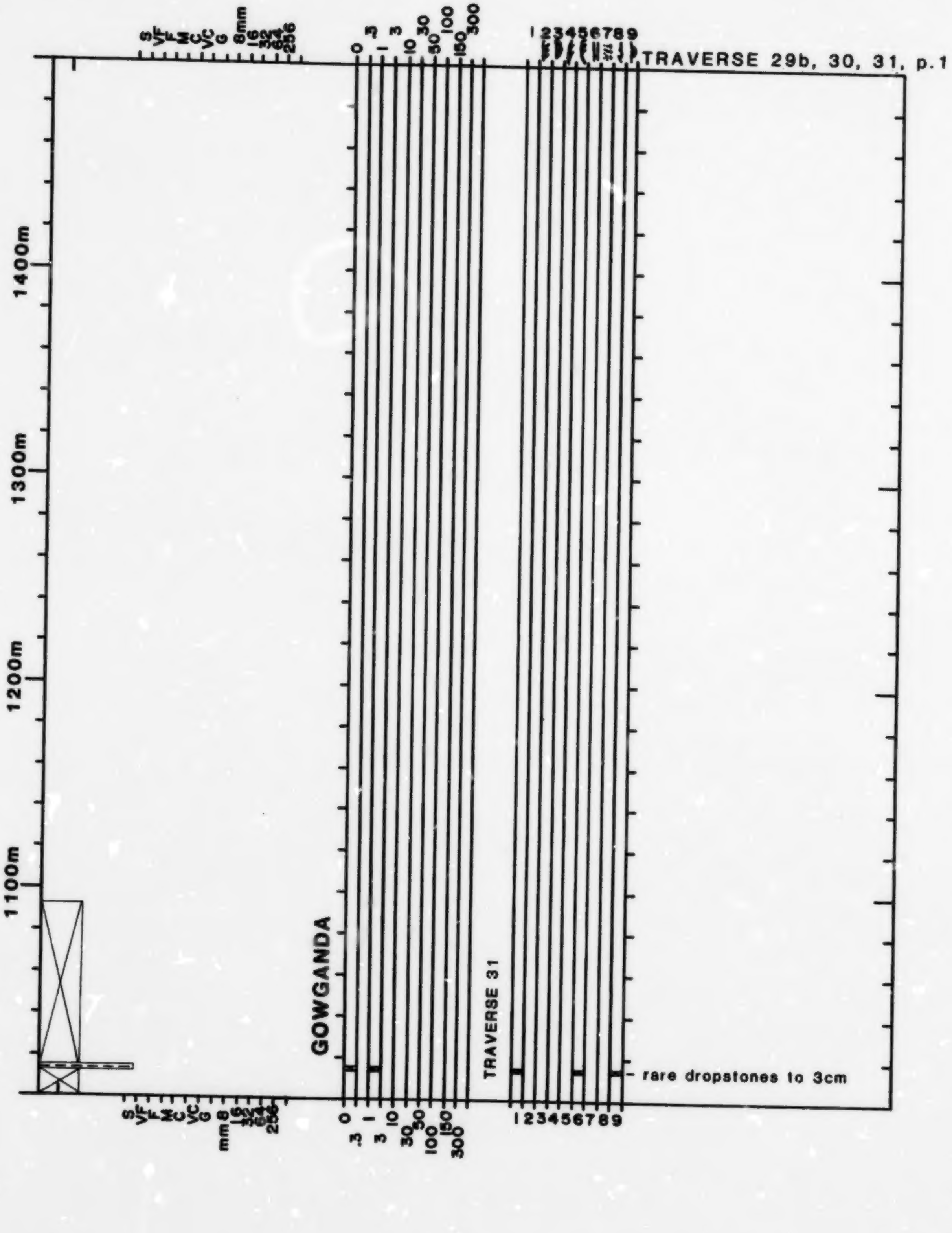

TRAVERSE 23a
250m
200m
150m
100m
50m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
PECORS
M
PECORS?
PECORS
NIPISSING
2312
2309
Top determinations in lower part of section not possible. Siltstone in lower part of section may be Pecors Formation repeated by folding
- pebbly wacke
- SLTST, SUBARK and CONG form channels
- ARK
- CONG
- SUBARK
- ARK, CONG
- Nipissing gabbro

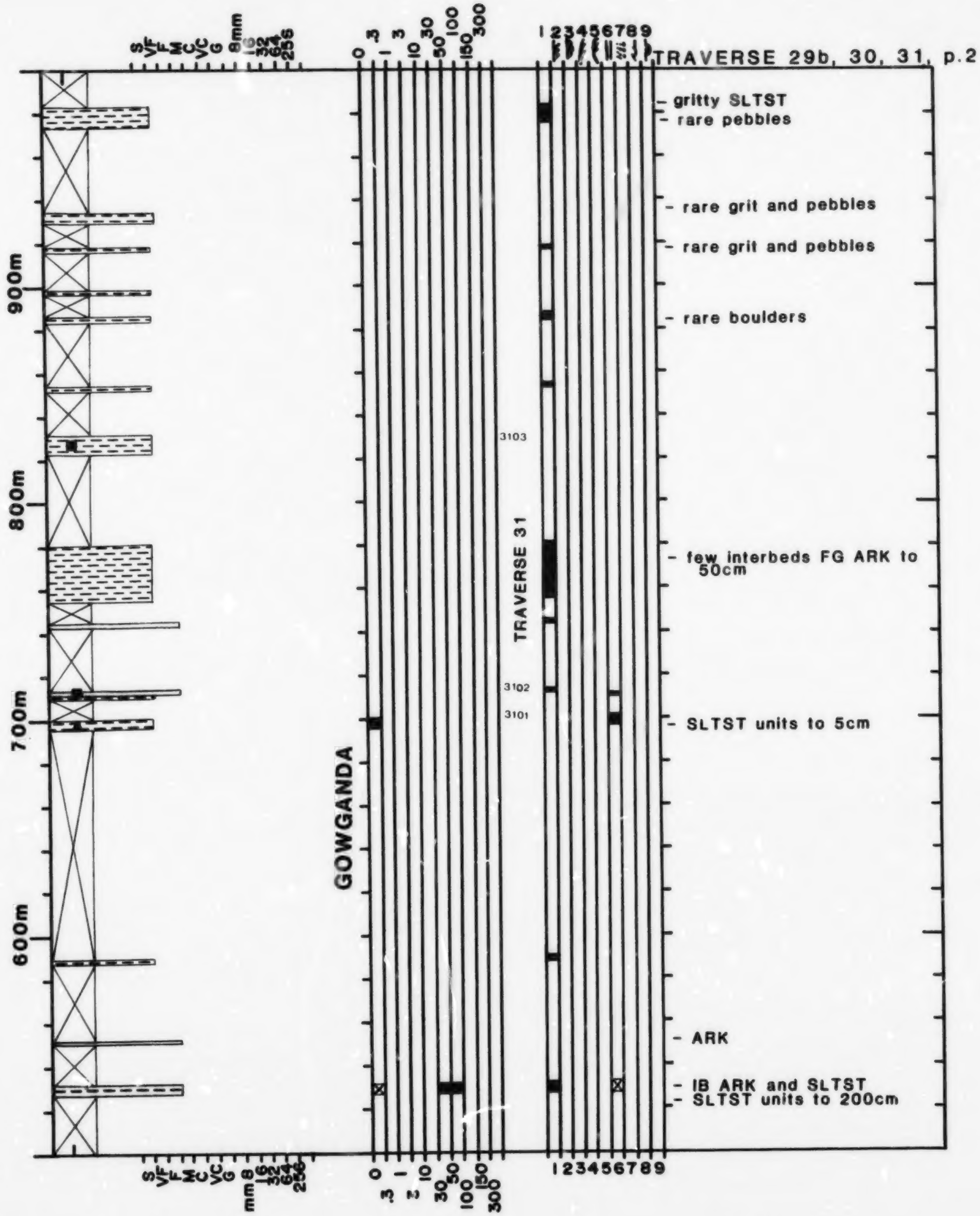

TRAVERSE 26
250m
200m
150m
100m
50m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
PECORS
M
S
2604
2603
2602
2601
contact sharp, not scoured
SUBARK, few IB SLTST beds
SLTST
argillaceous SLTST
SLTST, wacke and CONG
basalt

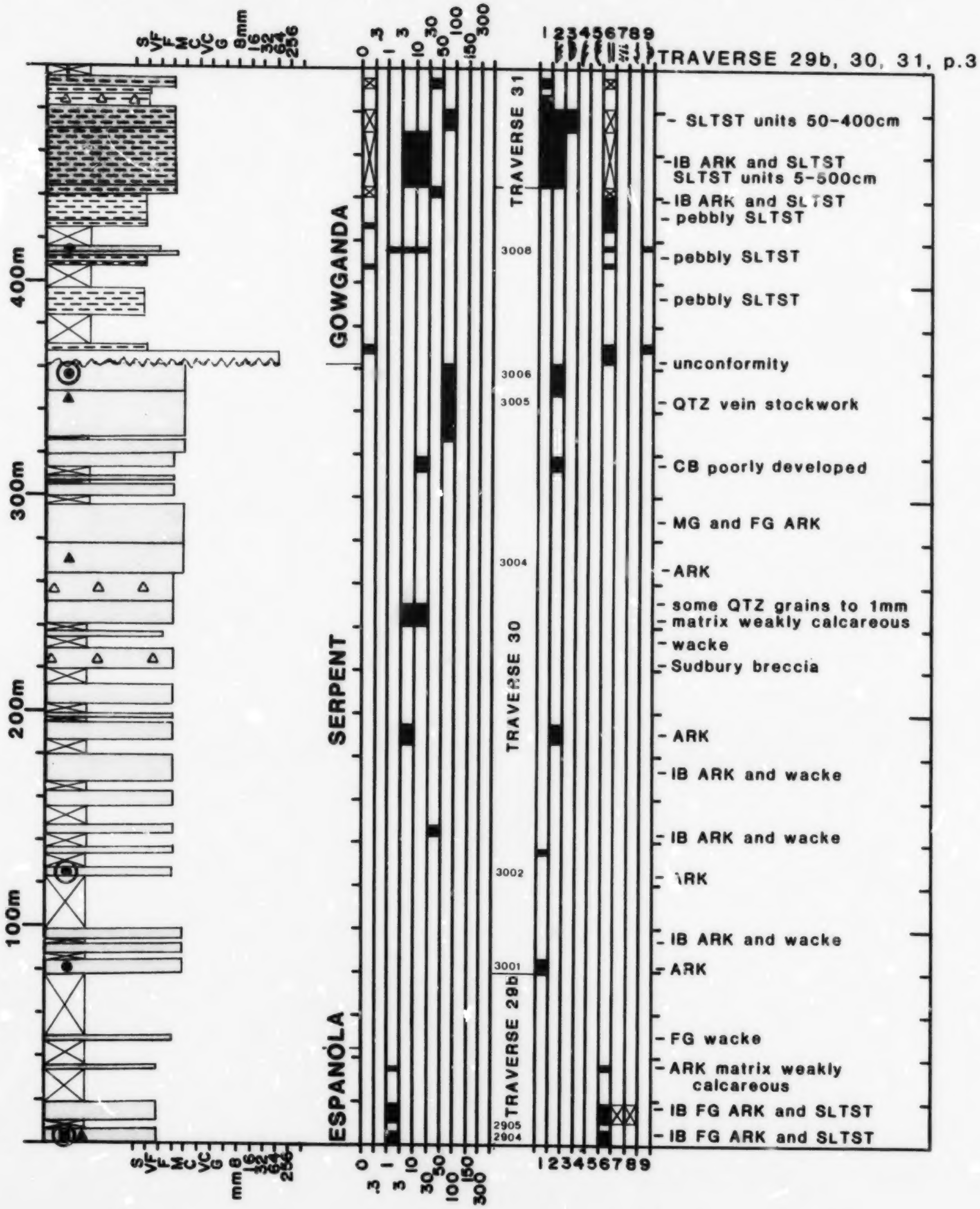

TRAVERSE 27
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
200m
150m
100m
50m
STOBIE
2702
pillowed
intraformational breccia
pillowed
polymictic paraCONG
wacke
flow top breccia
flow banding
pillowed

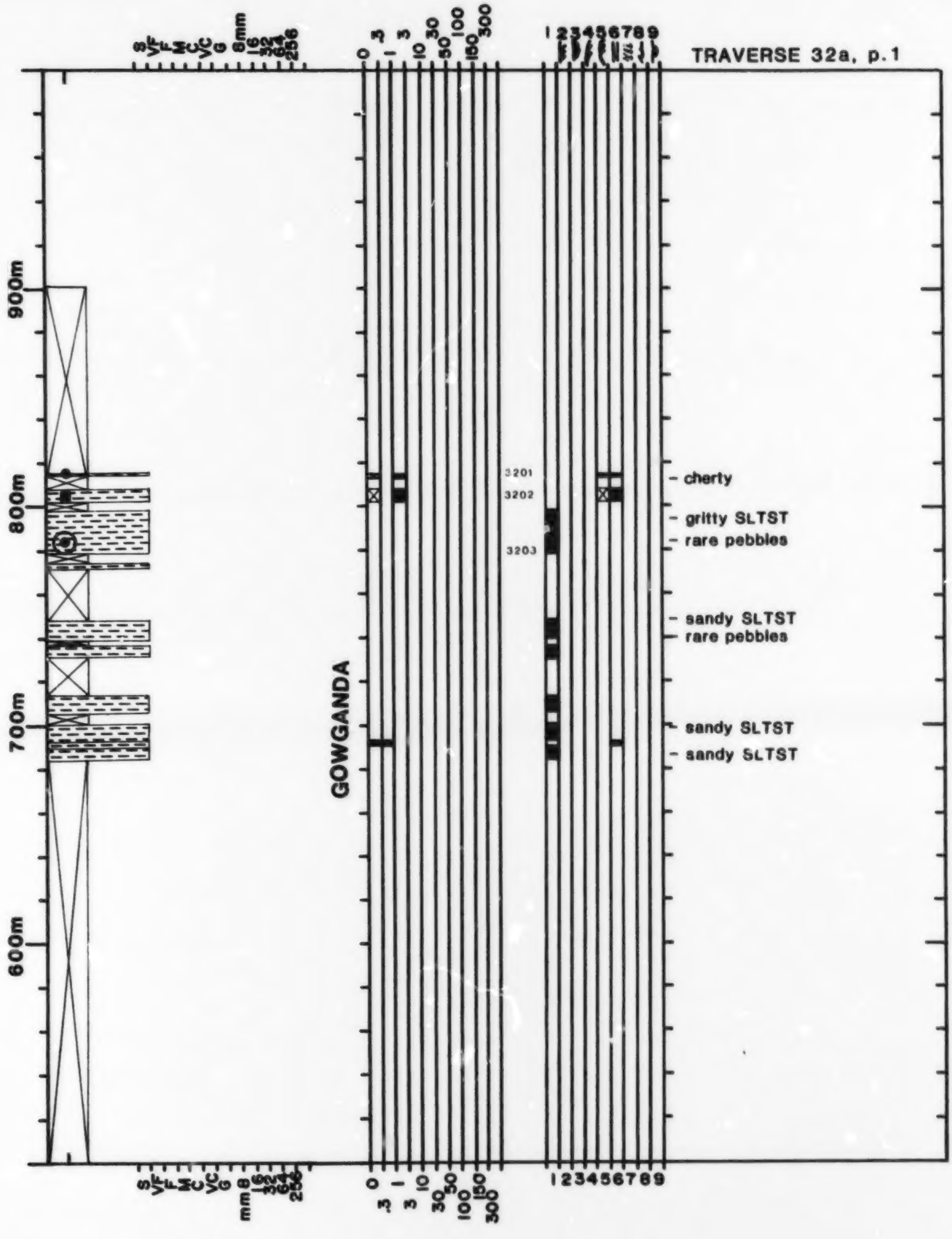

TRAVERSE 28a
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
SERPENT
ESPANOLA
ARK to arkosic wacke
few faint PL
ARK
PL poorly developed
IB ARK and FG wacke
breccia fragments of IB FG ARK and SLTST
calcareous wacke
IB LST and SLTST skarn
Nipissing gabbro
weakly calcareous
Sudbury breccia, fragments elongate, aligned
fragments PL, FG wacke and SLTST

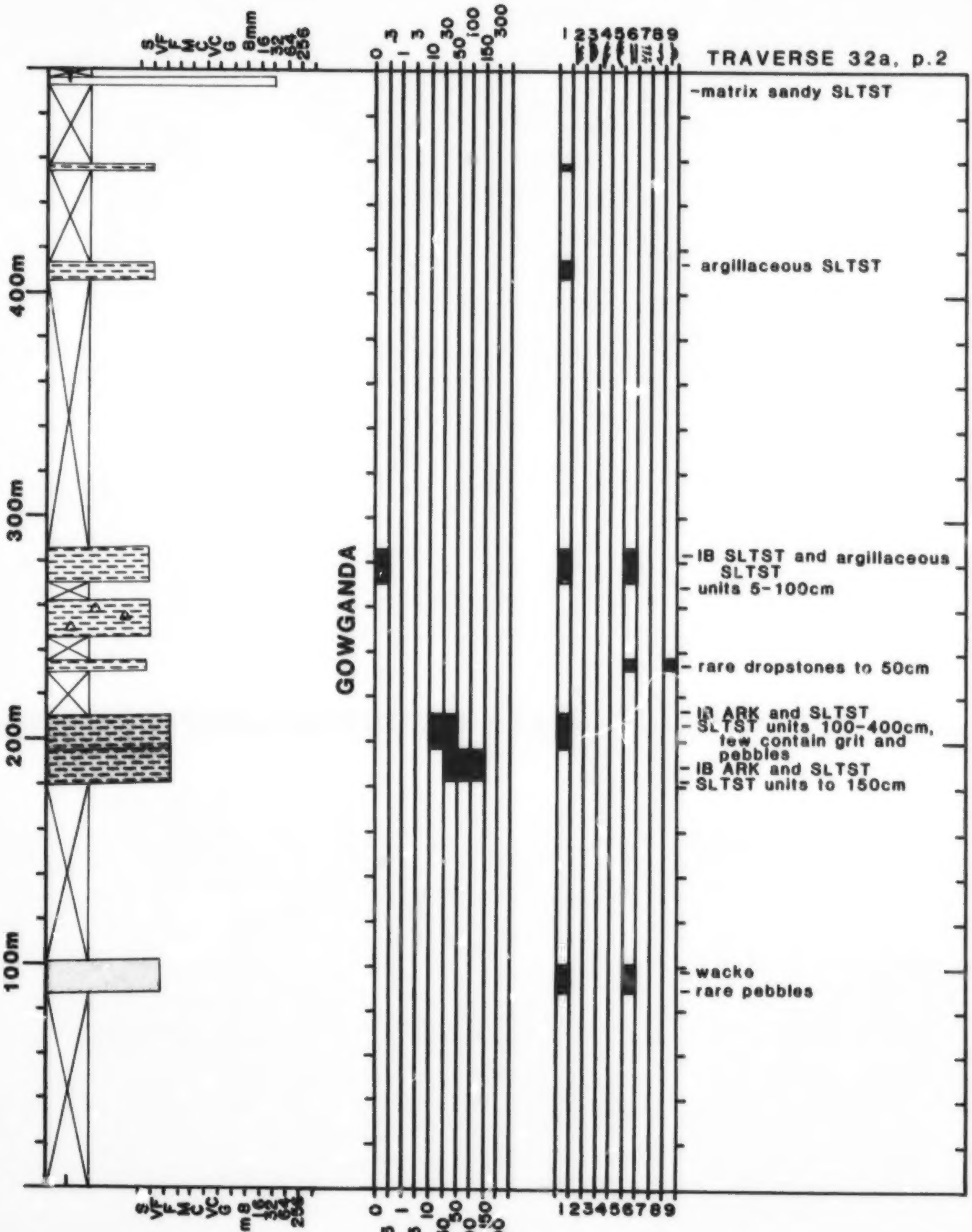

TRAVERSE 29a
BRUCE
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
ARK
matrix weakly calcareous
matrix FG silty wacke
wacke
matrix silty wacke
2 FG ARK interbeds
IB pebbly wacke and ARK
ARK
matrix MG-CG wacke
2001

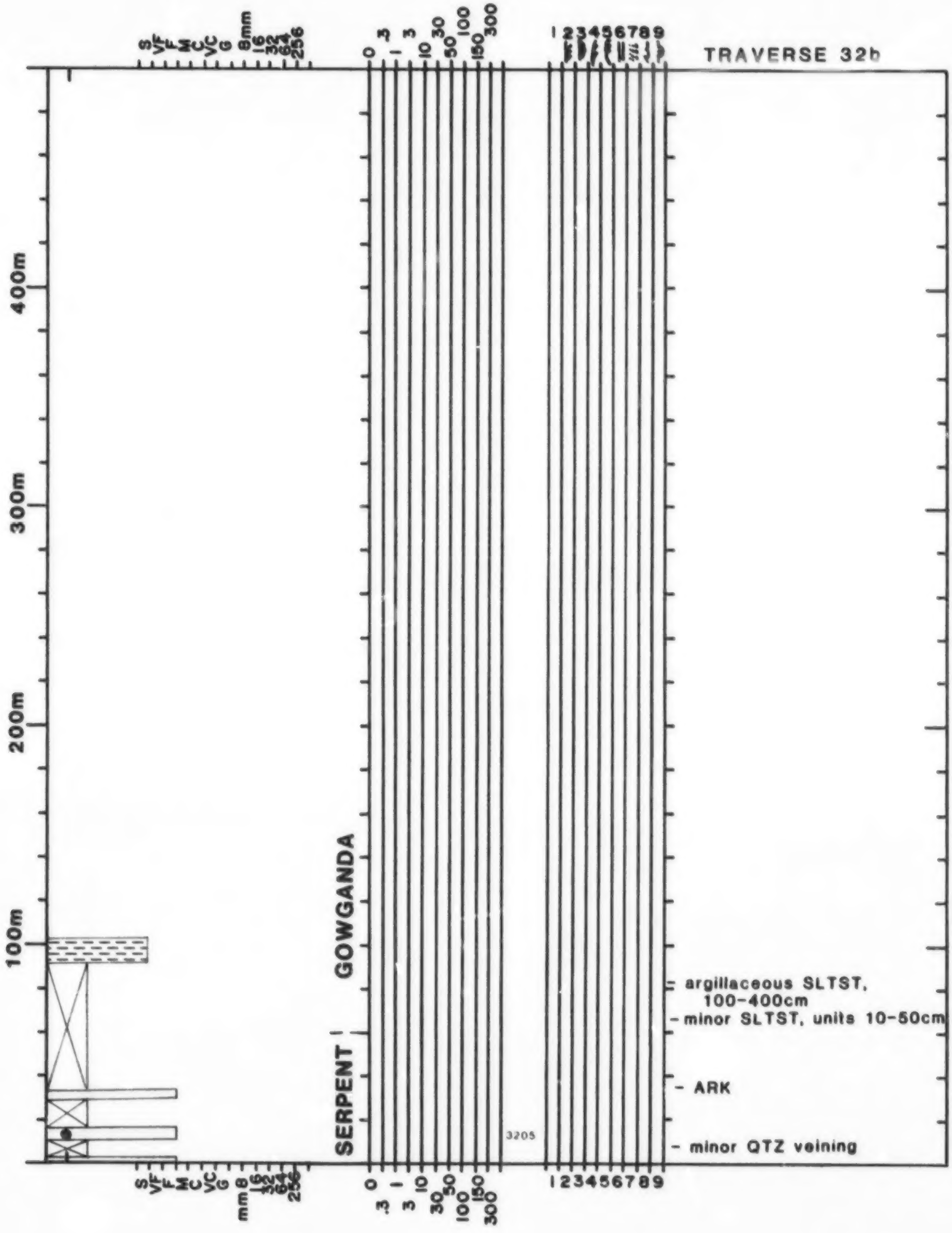

TRAVERSE 29b, 30, 31, p.1
S
VF
F
M
C
VC
G
8mm
16
32
64
256
0
.3
1
3
10
30
50
100
150
300
1
2
3
4
5
6
7
8
9
1400m
1300m
1200m
1100m
GOWGANDA
TRAVERSE 31
rare dropstones to 3cm

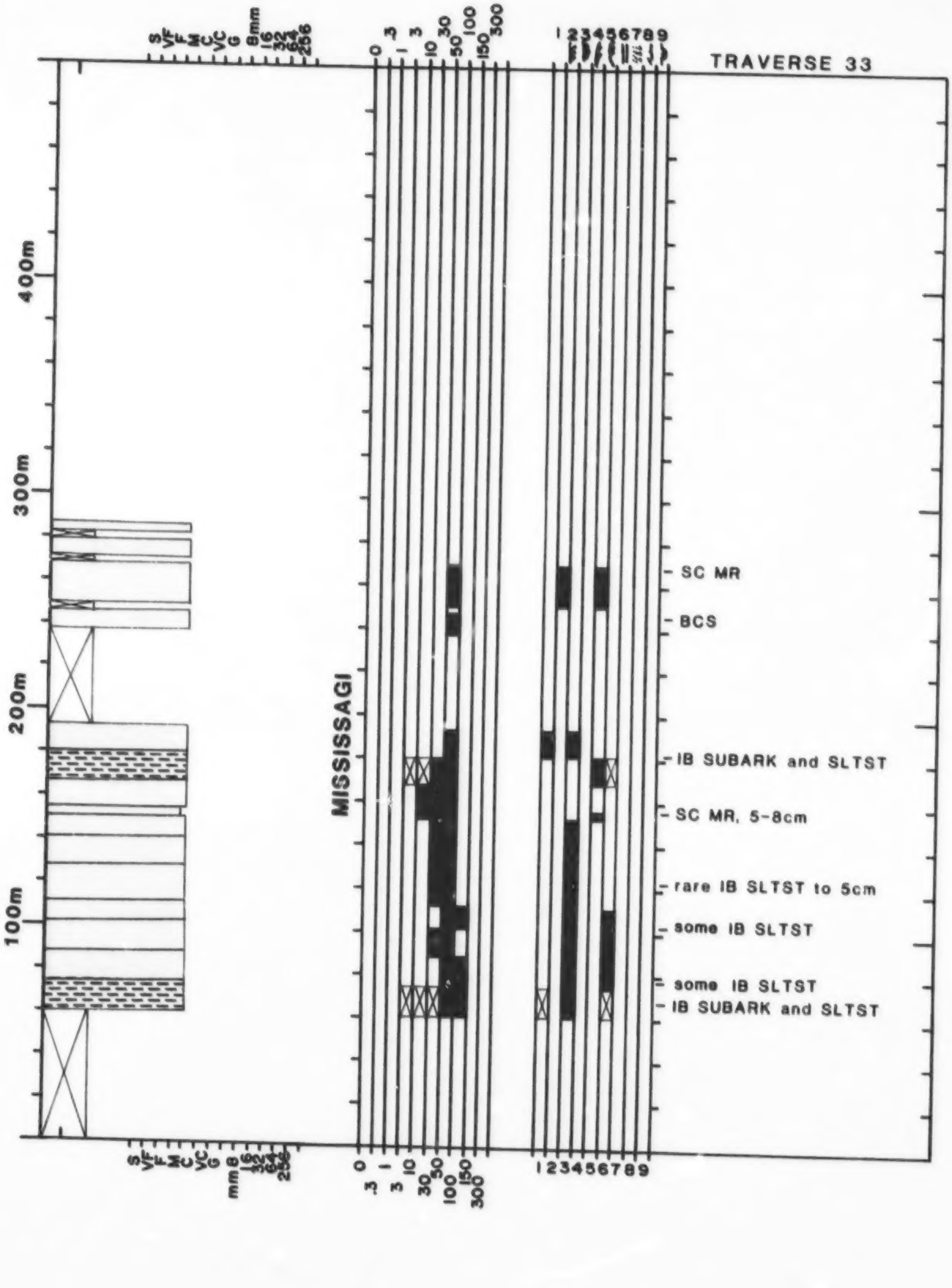

TRAVERSE 29b, 30, 31, p.2
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
900m
800m
700m
600m
GOWGANDA
TRAVERSE 31
3103
3102
3101
- gritty SLTST
- rare pebbles
- rare grit and pebbles
- rare grit and pebbles
- rare boulders
- few interbeds FG ARK to 50cm
- SLTST units to 5cm
- ARK
- IB ARK and SLTST
- SLTST units to 200cm

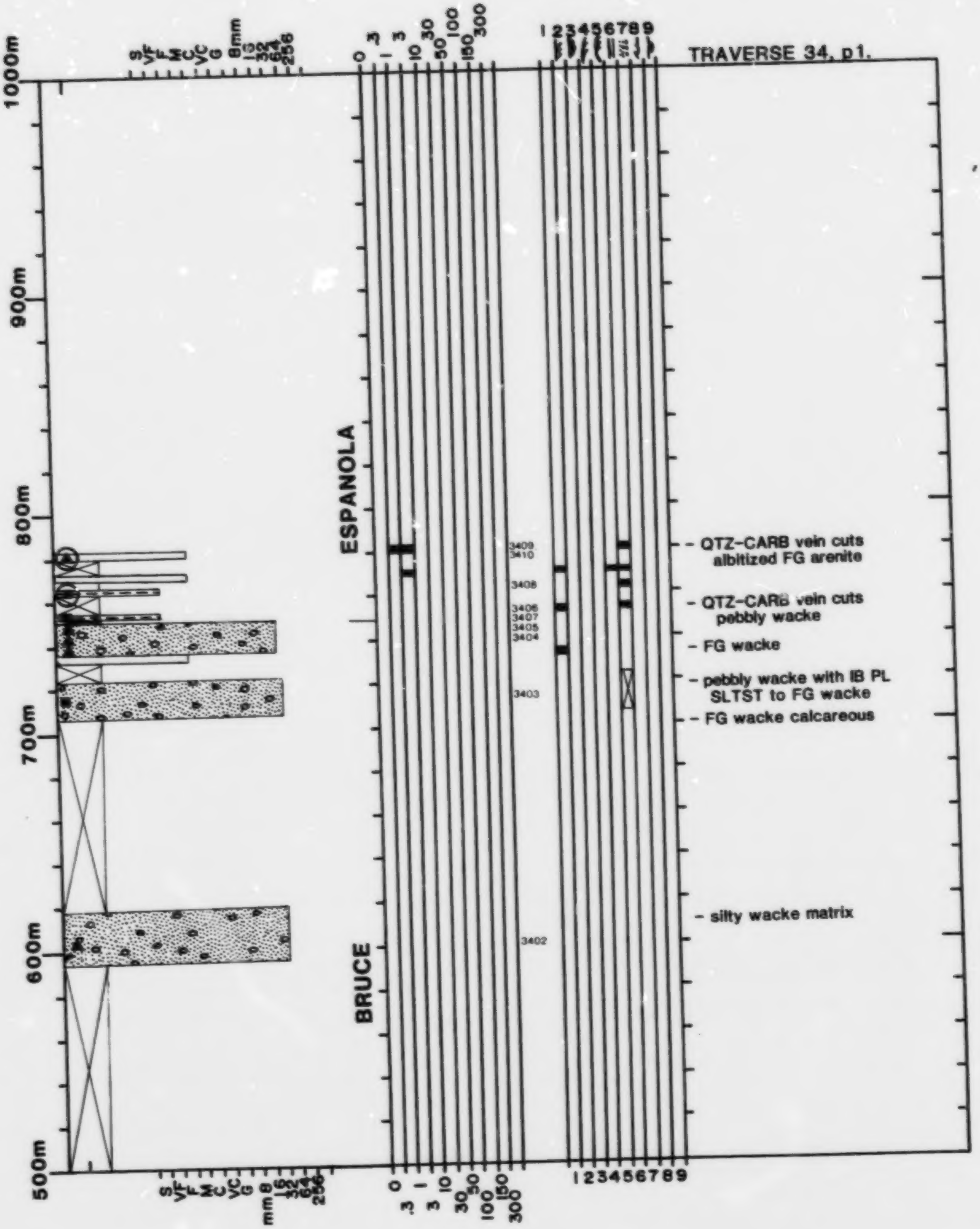

TRAVERSE 29b, 30, 31, p.3
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
GOWGANDA
SERPENT
ESPANOLA
TRAVERSE 31
TRAVERSE 30
TRAVERSE 29b
3008
3006
3005
3004
3002
3001
2905
2904
- SLTST units 50-400cm
- IB ARK and SLTST SLTST units 5-500cm
- IB ARK and SLTST
- pebbly SLTST
- pebbly SLTST
- pebbly SLTST
- unconformity
- QTZ vein stockwork
- CB poorly developed
- MG and FG ARK
- ARK
- some QTZ grains to 1mm
- matrix weakly calcareous
- wacke
- Sudbury breccia
- ARK
- IB ARK and wacke
- IB ARK and wacke
- ARK
- IB ARK and wacke
- ARK
- FG wacke
- ARK matrix weakly calcareous
- IB FG ARK and SLTST
- IB FG ARK and SLTST

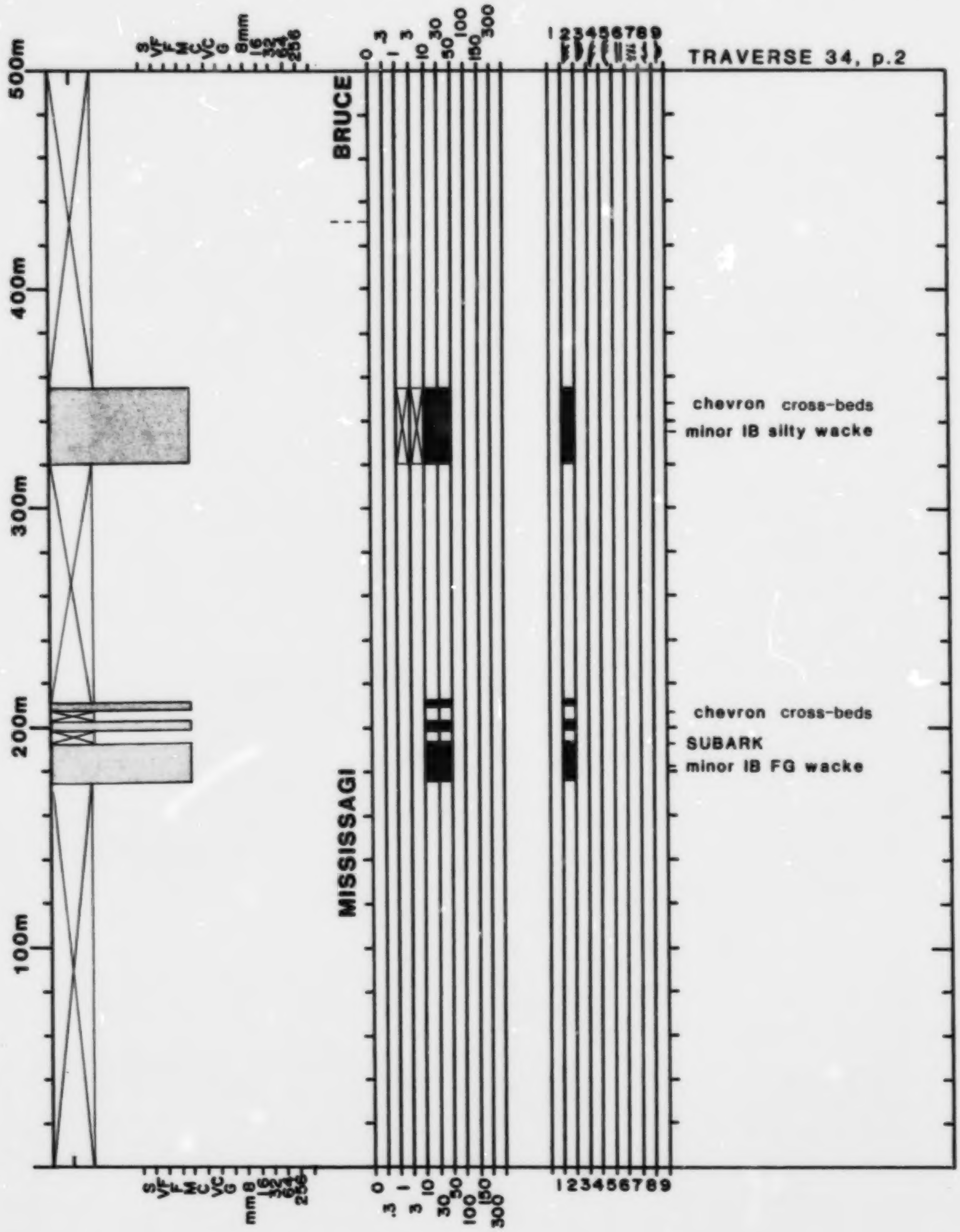

TRAVERSE 32a, p.1
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
900m
800m
700m
600m
GOWGANDA
3201
3202
3203
- cherty
- gritty SLTST
- rare pebbles
- sandy SLTST
- rare pebbles
- sandy SLTST
- sandy SLTST

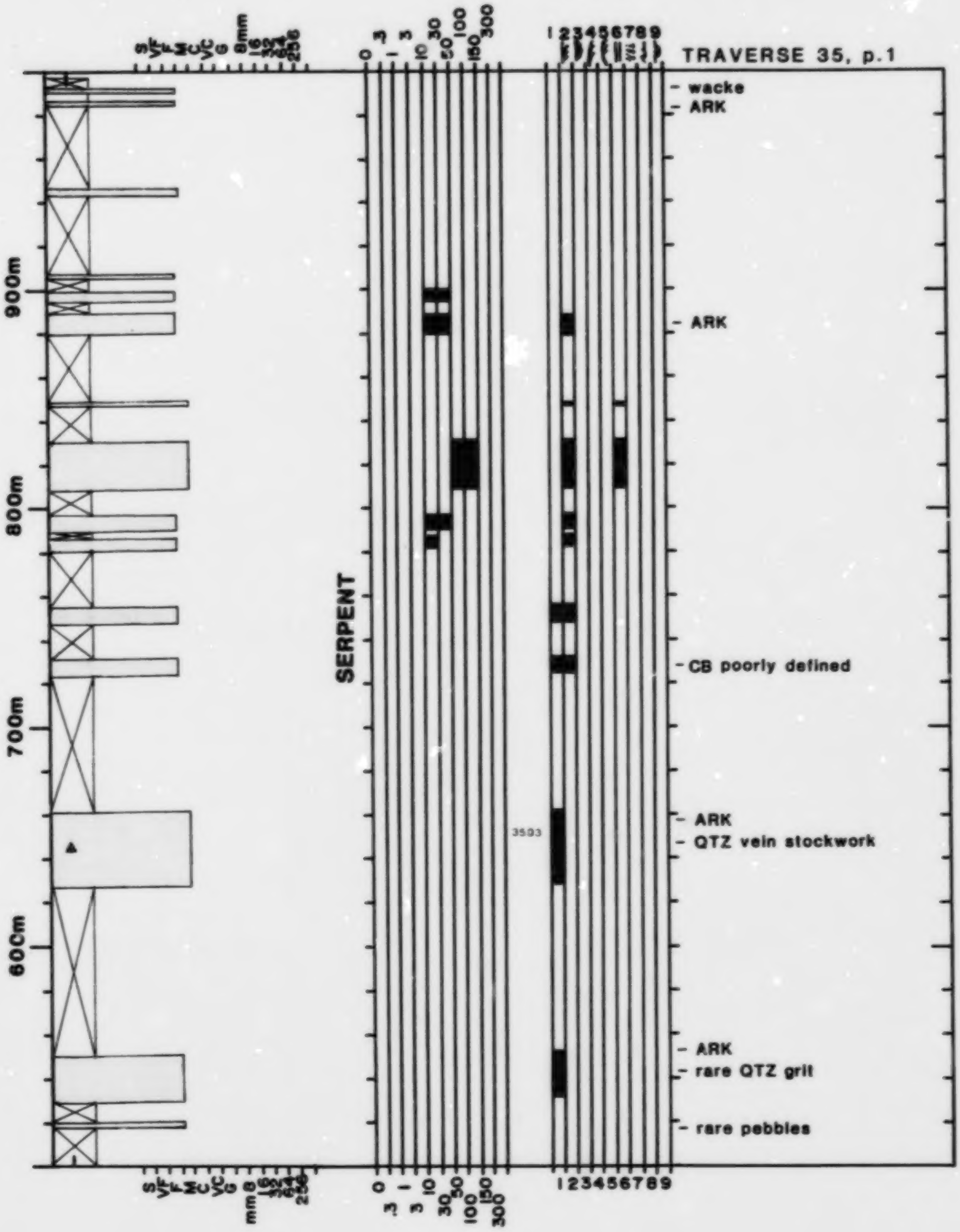

TRAVERSE 32a, p.2
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
GOWGANDA
-matrix sandy SLTST
- argillaceous SLTST
- IB SLTST and argillaceous SLTST
- units 5-100cm
- rare dropstones to 50cm
- IB ARK and SLTST
- SLTST units 100-400cm, few contain grit and pebbles
- IB ARK and SLTST
- SLTST units to 150cm
- wacke
- rare pebbles

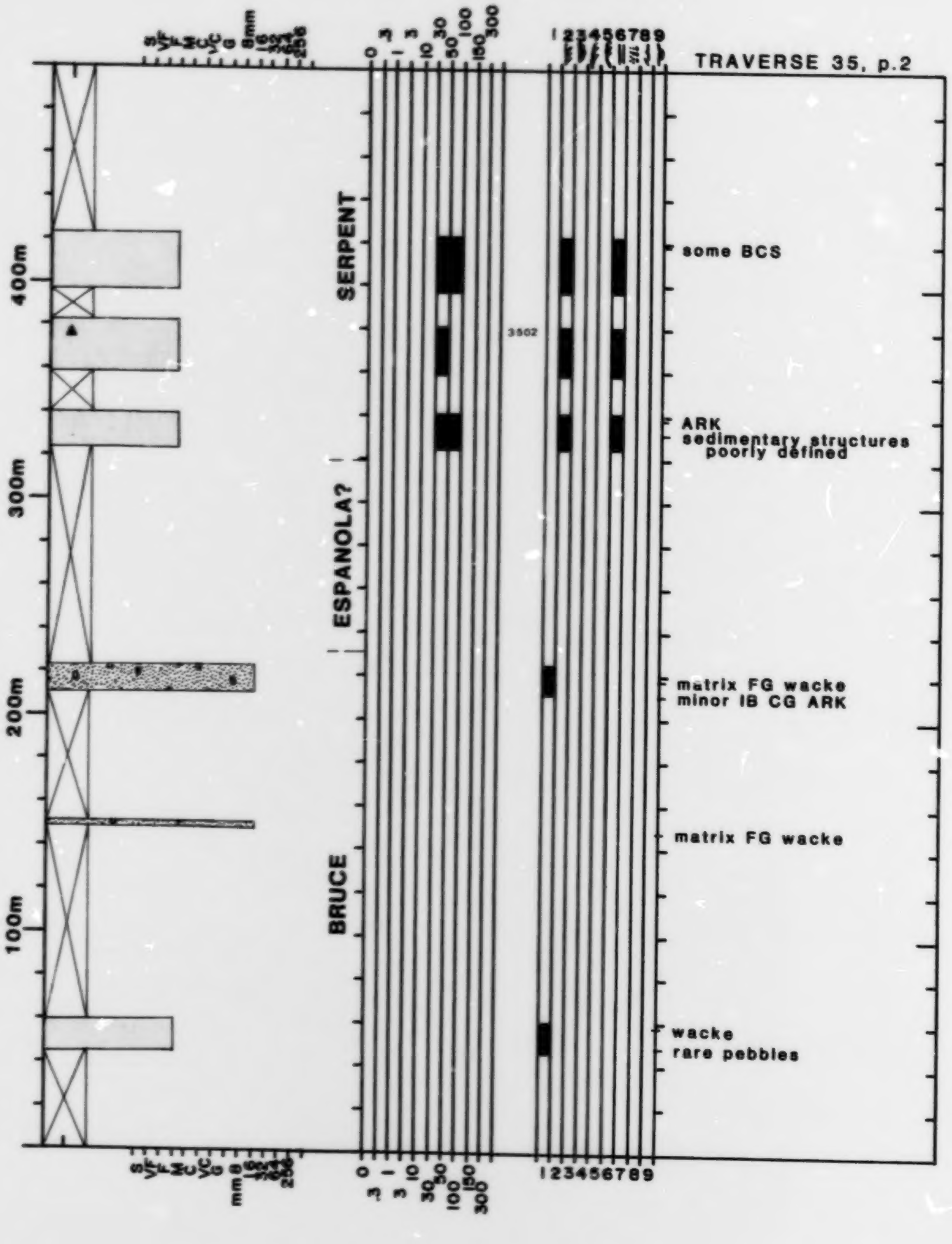

TRAVERSE 32b
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
400m
300m
200m
100m
GOWGANDA
SERPENT
argillaceous SLTST, 100-400cm
minor SLTST, units 10-50cm
ARK
minor QTZ veining
3205

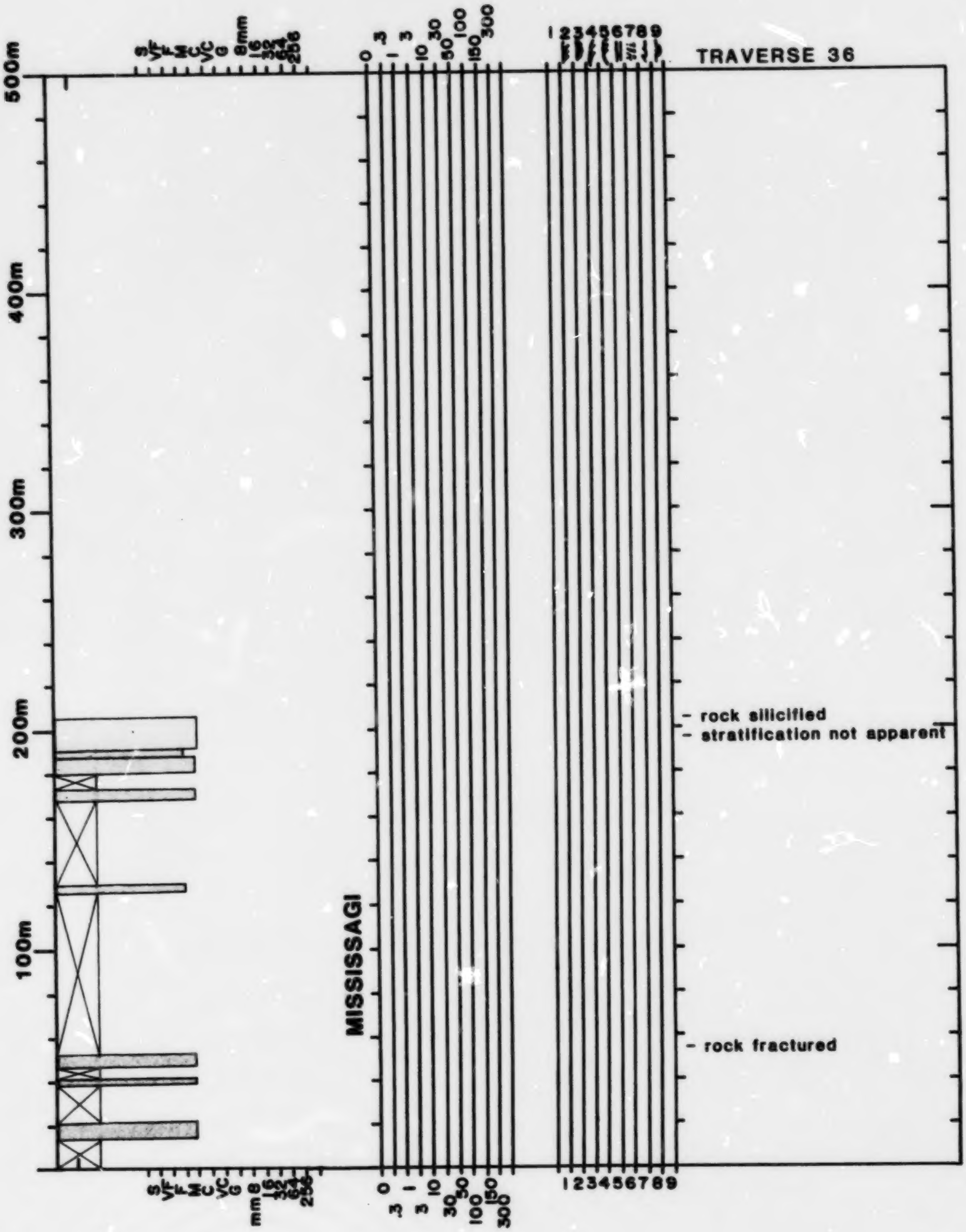

TRAVERSE 33
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
SC MR
BCS
IB SUBARK and SLTST
SC MR, 5-8cm
rare IB SLTST to 5cm
some IB SLTST
some IB SLTST
IB SUBARK and SLTST

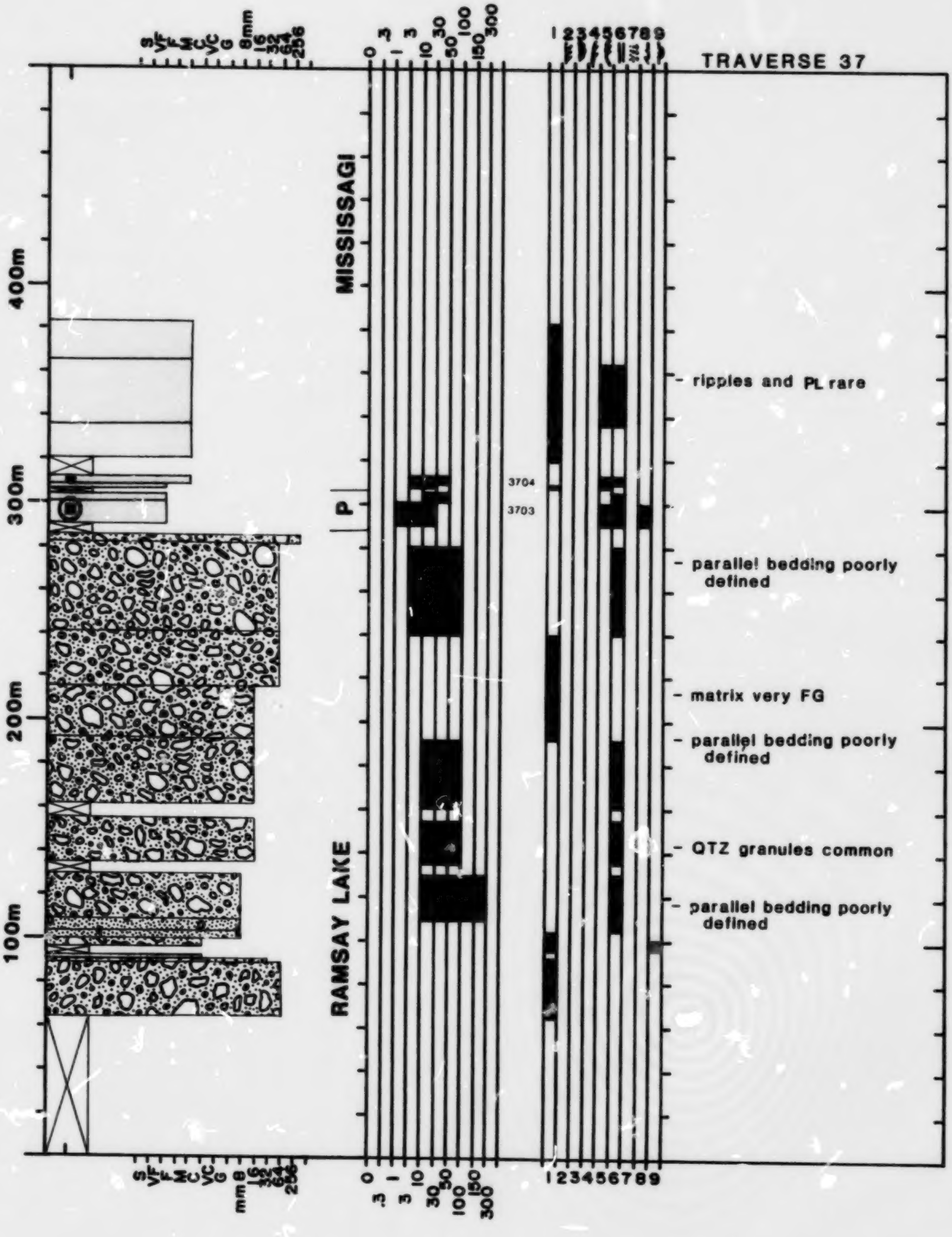

TRAVERSE 34, p1.
1000m
900m
800m
700m
600m
500m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
ESPANOLA
BRUCE
3409
3410
3408
3406
3407
3405
3404
3403
3402
- QTZ-CARB vein cuts albitized FG arenite
- QTZ-CARB vein cuts pebbly wacke
- FG wacke
- pebbly wacke with IB PL SLTST to FG wacke
- FG wacke calcareous
- silty wacke matrix

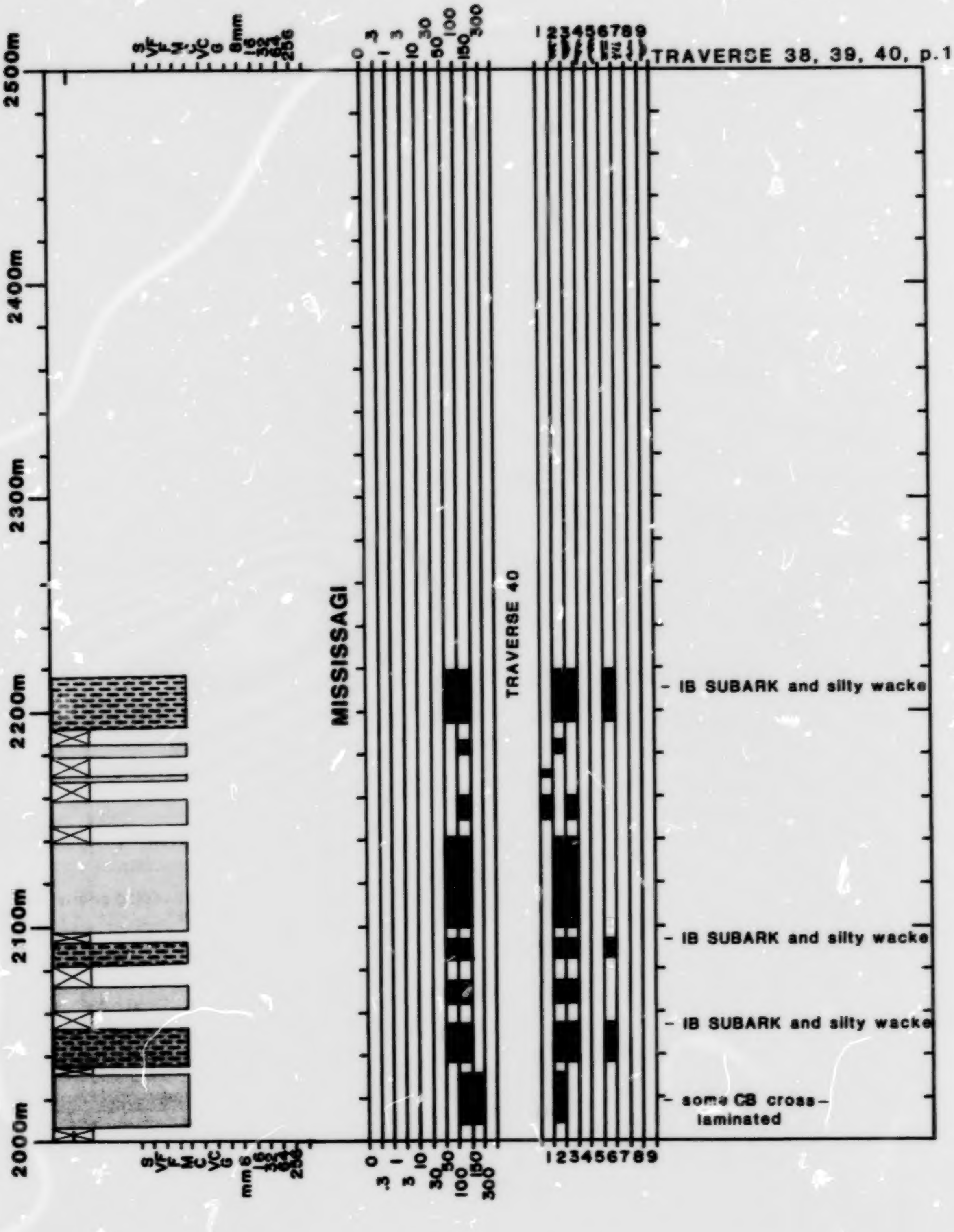

TRAVERSE 34, p.2
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
BRUCE
MISSISSAGI
chevron cross-beds
minor IB silty wacke
chevron cross-beds
SUBARK
minor IB FG wacke

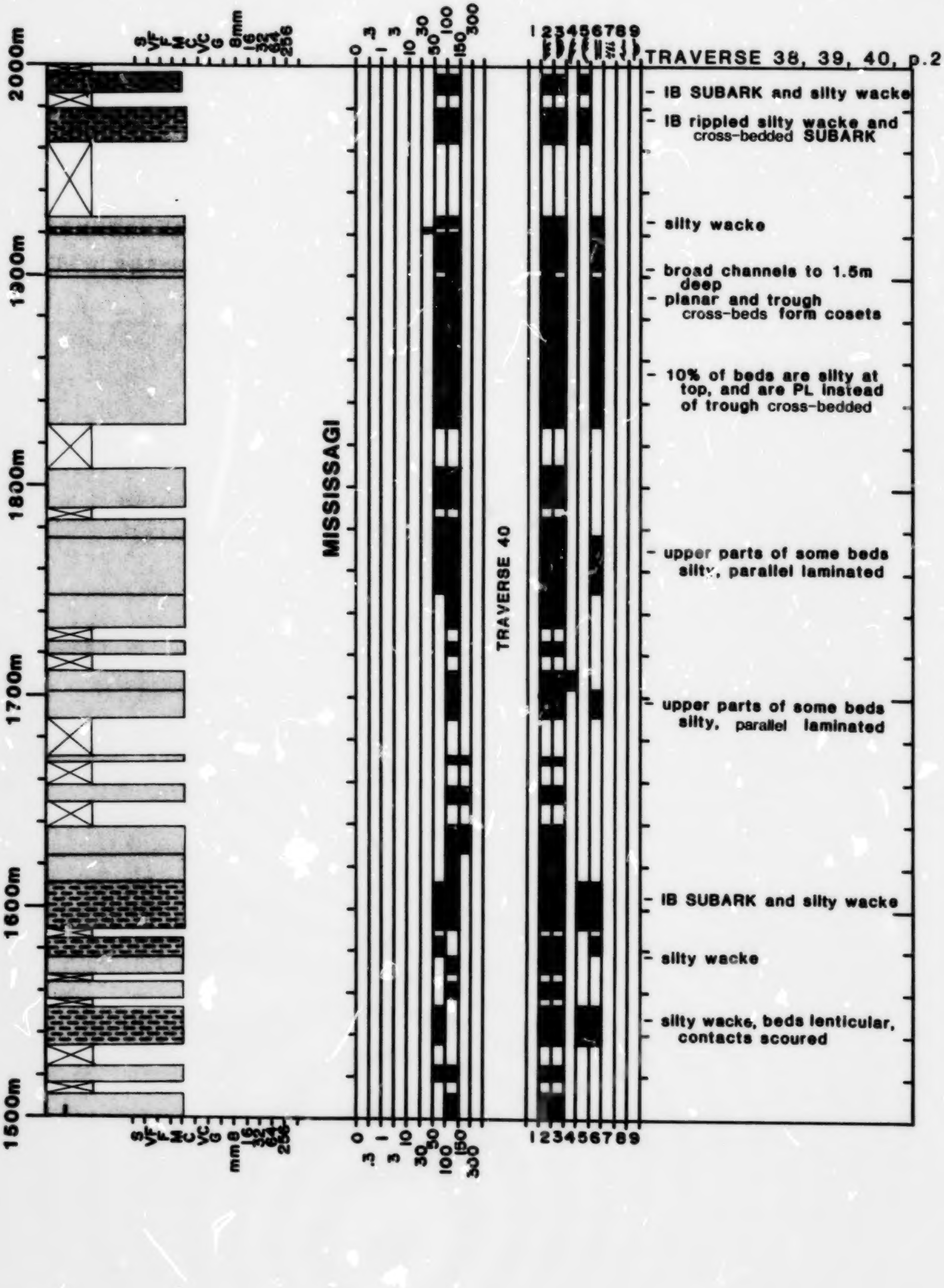

TRAVERSE 35, p.1
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
900m
800m
700m
600m
SERPENT
3593
- wacke
- ARK
- ARK
- CB poorly defined
- ARK
- QTZ vein stockwork
- ARK
- rare QTZ grit
- rare pebbles

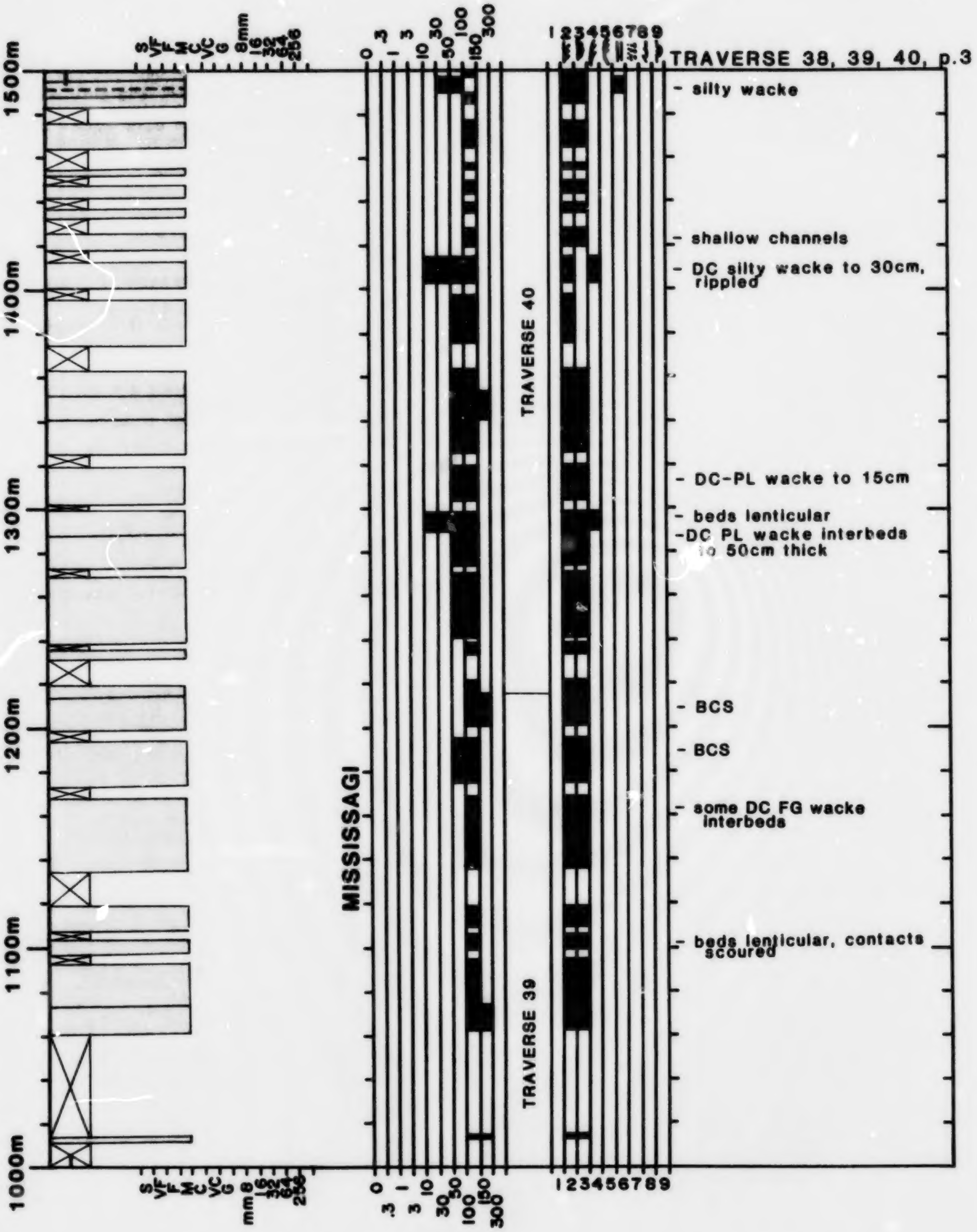

TRAVERSE 35, p.2
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
SERPENT
ESPANOLA?
BRUCE
3502
some BCS
ARK
sedimentary structures
poorly defined
matrix FG wacke
minor IB CG ARK
matrix FG wacke
wacke
rare pebbles

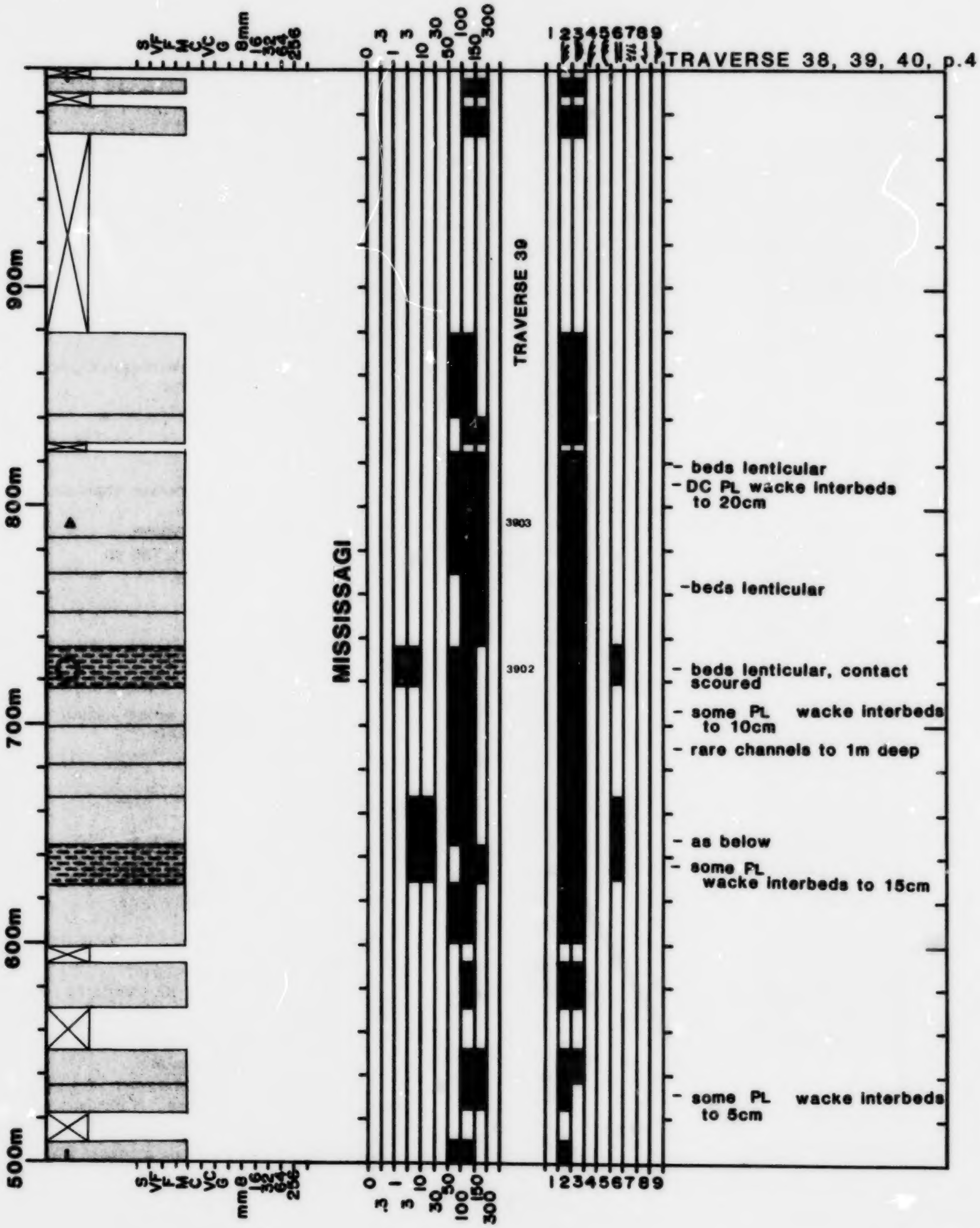

TRAVERSE 36
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
- rock silicified
- stratification not apparent
- rock fractured

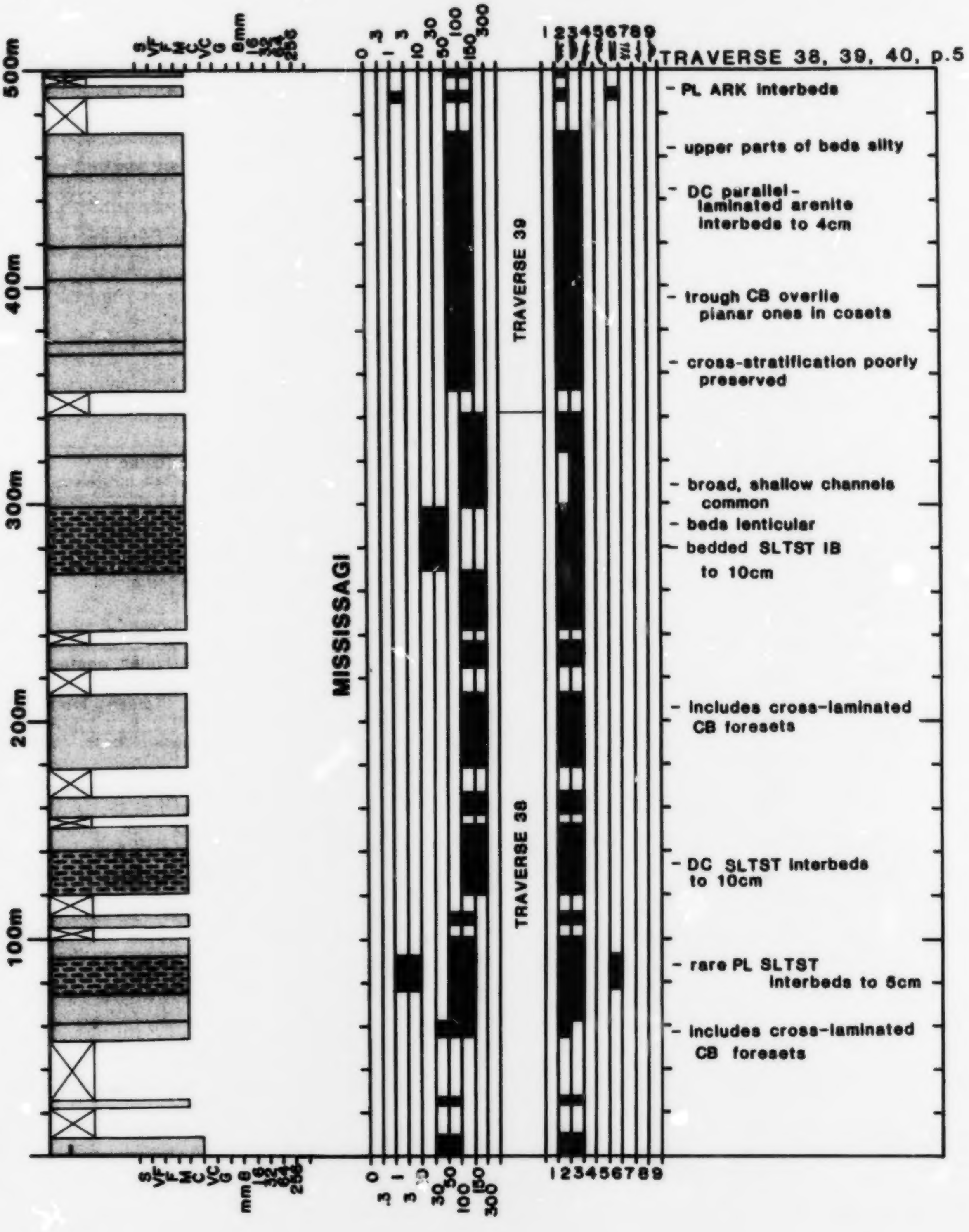

TRAVERSE 37
400m
300m
200m
100m
S
VF
F
M
C
VC
G
mm 8
16
32
64
256
0
.3
1
3
10
30
50
100
150
300
1 2 3 4 5 6 7 8 9
MISSISSAGI
P
RAMSAY LAKE
3704
3703
- ripples and PL rare
- parallel bedding poorly defined
- matrix very FG
- parallel bedding poorly defined
- QTZ granules common
- parallel bedding poorly defined

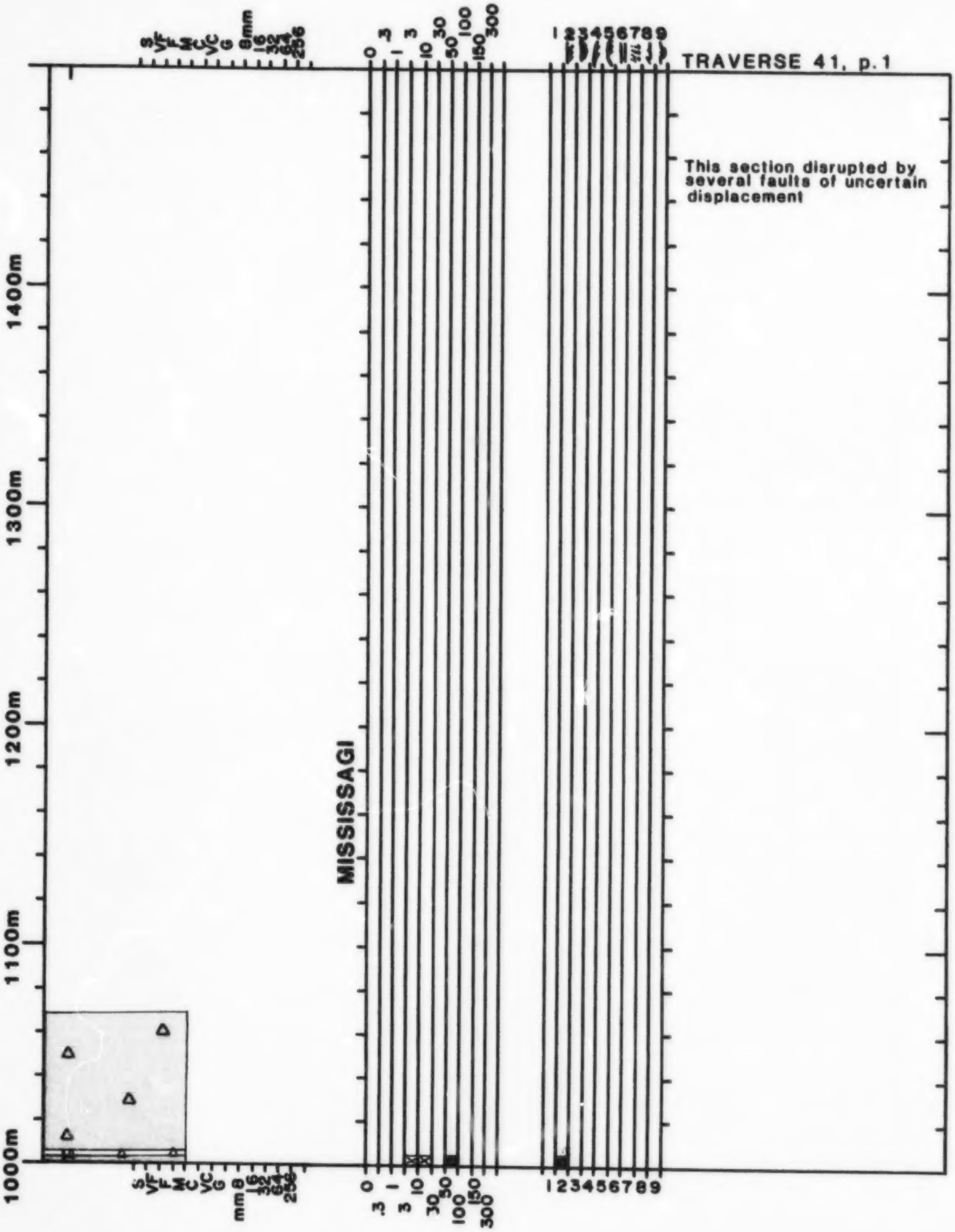

TRAVERSE 38, 39, 40, p.1
2500m
2400m
2300m
2200m
2100m
2000m
S VF F M C VC G
8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
TRAVERSE 40
- IB SUBARK and silty wacke
- IB SUBARK and silty wacke
- IB SUBARK and silty wacke
- some CB cross-laminated


TRAVERSE 38, 39, 40, p.2
2000m
1900m
1800m
1700m
1600m
1500m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
TRAVERSE 40
IB SUBARK and silty wacke
IB rippled silty wacke and cross-bedded SUBARK
silty wacke
broad channels to 1.5m deep
planar and trough cross-beds form cosets
10% of beds are silty at top, and are PL instead of trough cross-bedded
upper parts of some beds silty, parallel laminated
upper parts of some beds silty, parallel laminated
IB SUBARK and silty wacke
silty wacke
silty wacke, beds lenticular, contacts scoured


TRAVERSE 38, 39, 40, p.3
1500m
1400m
1300m
1200m
1100m
1000m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
TRAVERSE 40
TRAVERSE 39
MISSISSAGI
- silty wacke
- shallow channels
- DC silty wacke to 30cm, rippled
- DC-PL wacke to 15cm
- beds lenticular
-DC PL wacke interbeds to 50cm thick
- BCS
- BCS
- some DC FG wacke interbeds
- beds lenticular, contacts scoured

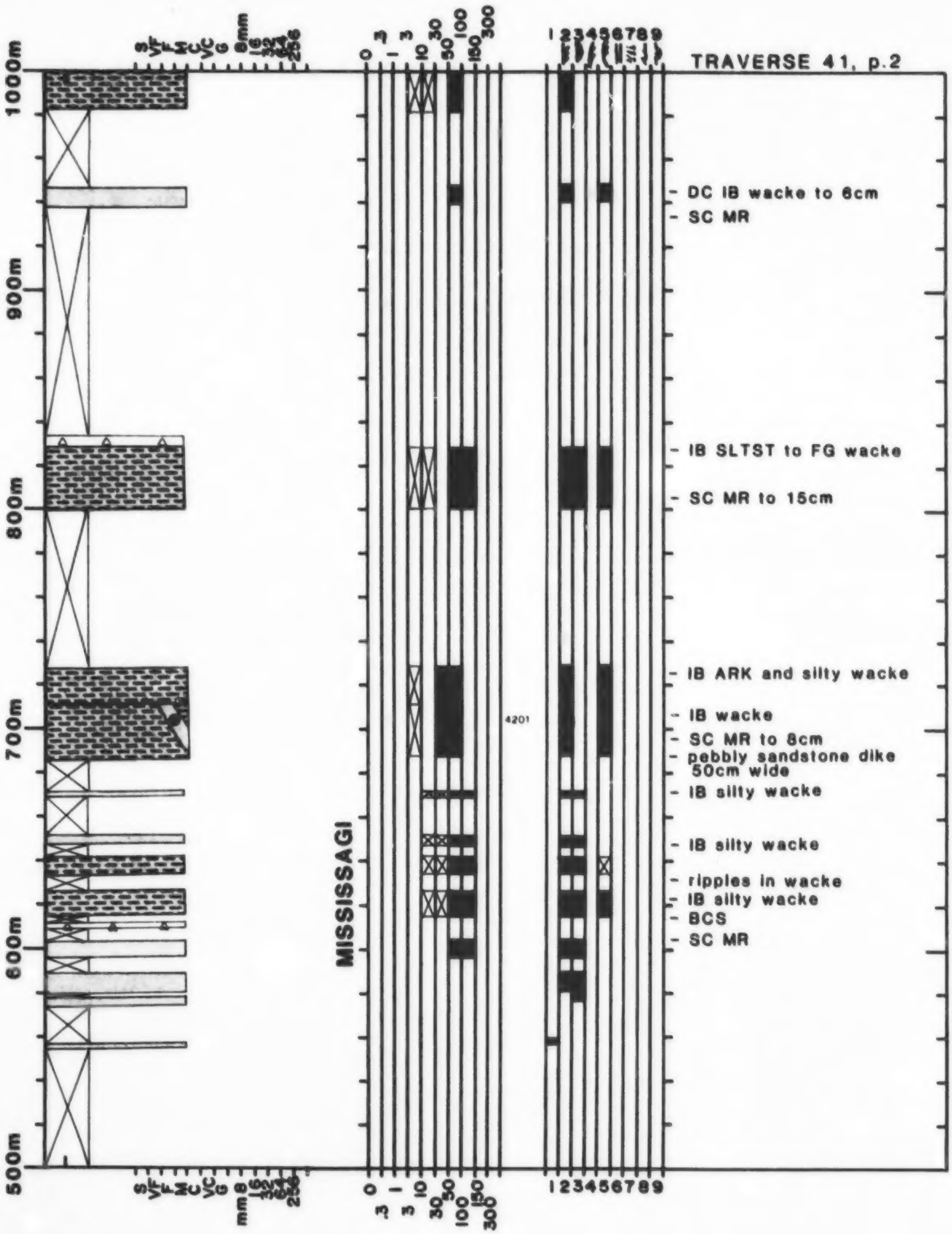

TRAVERSE 38, 39, 40, p.4
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
500m
600m
700m
800m
900m
MISSISSAGI
TRAVERSE 39
3903
3902
- beds lenticular
- DC PL wacke interbeds to 20cm
-beds lenticular
- beds lenticular, contact scoured
- some PL wacke interbeds to 10cm
- rare channels to 1m deep
- as below
- some PL wacke interbeds to 15cm
- some PL wacke interbeds to 5cm

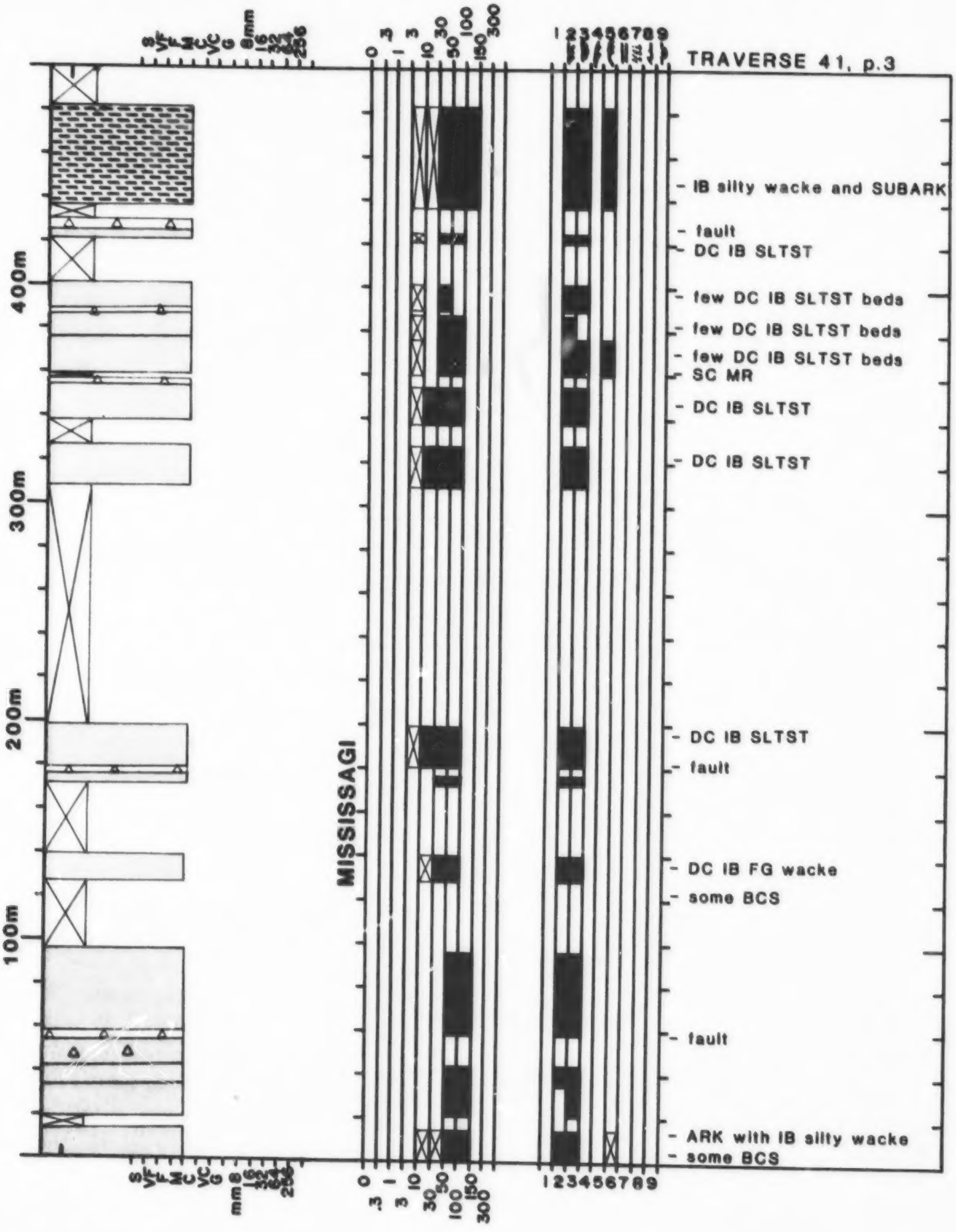

TRAVERSE 38, 39, 40, p.5
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
TRAVERSE 39
TRAVERSE 38
- PL ARK interbeds
- upper parts of beds silty
- DC parallel-laminated arenite interbeds to 4cm
- trough CB overlie planar ones in cosets
- cross-stratification poorly preserved
- broad, shallow channels common
- beds lenticular
- bedded SLTST IB to 10cm
- includes cross-laminated CB foresets
- DC SLTST interbeds to 10cm
- rare PL SLTST interbeds to 5cm
- includes cross-laminated CB foresets

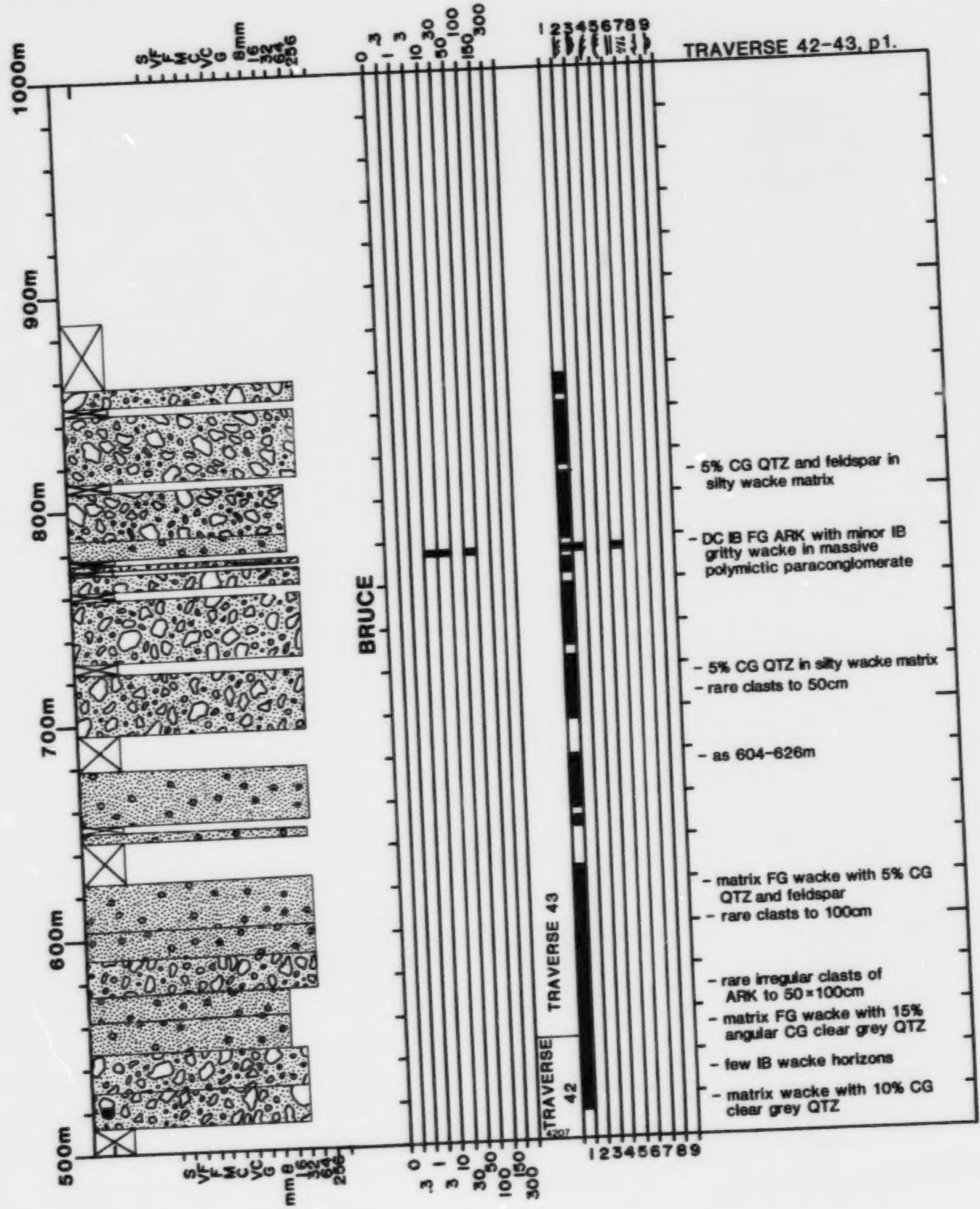


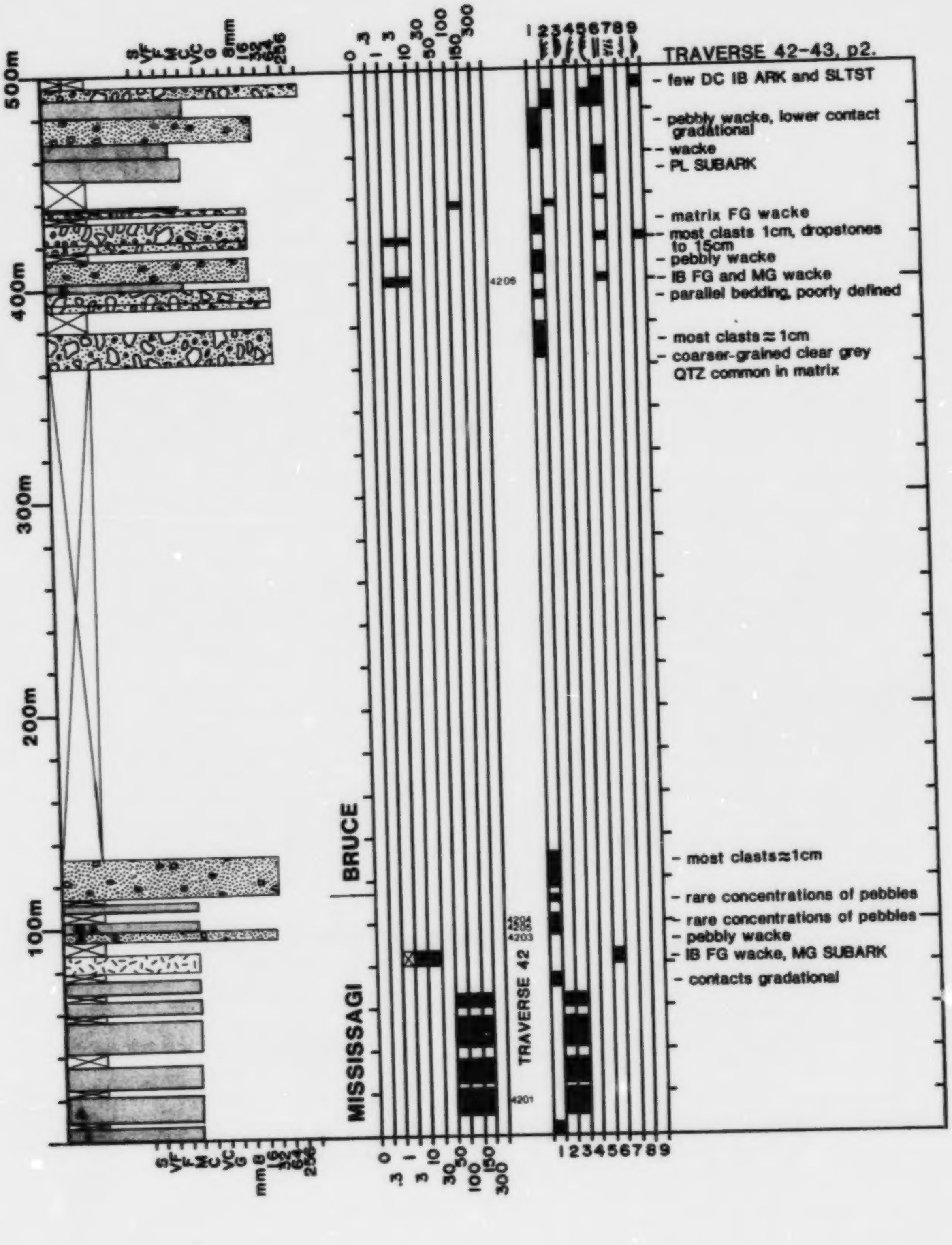
TRAVERSE 41, p.1

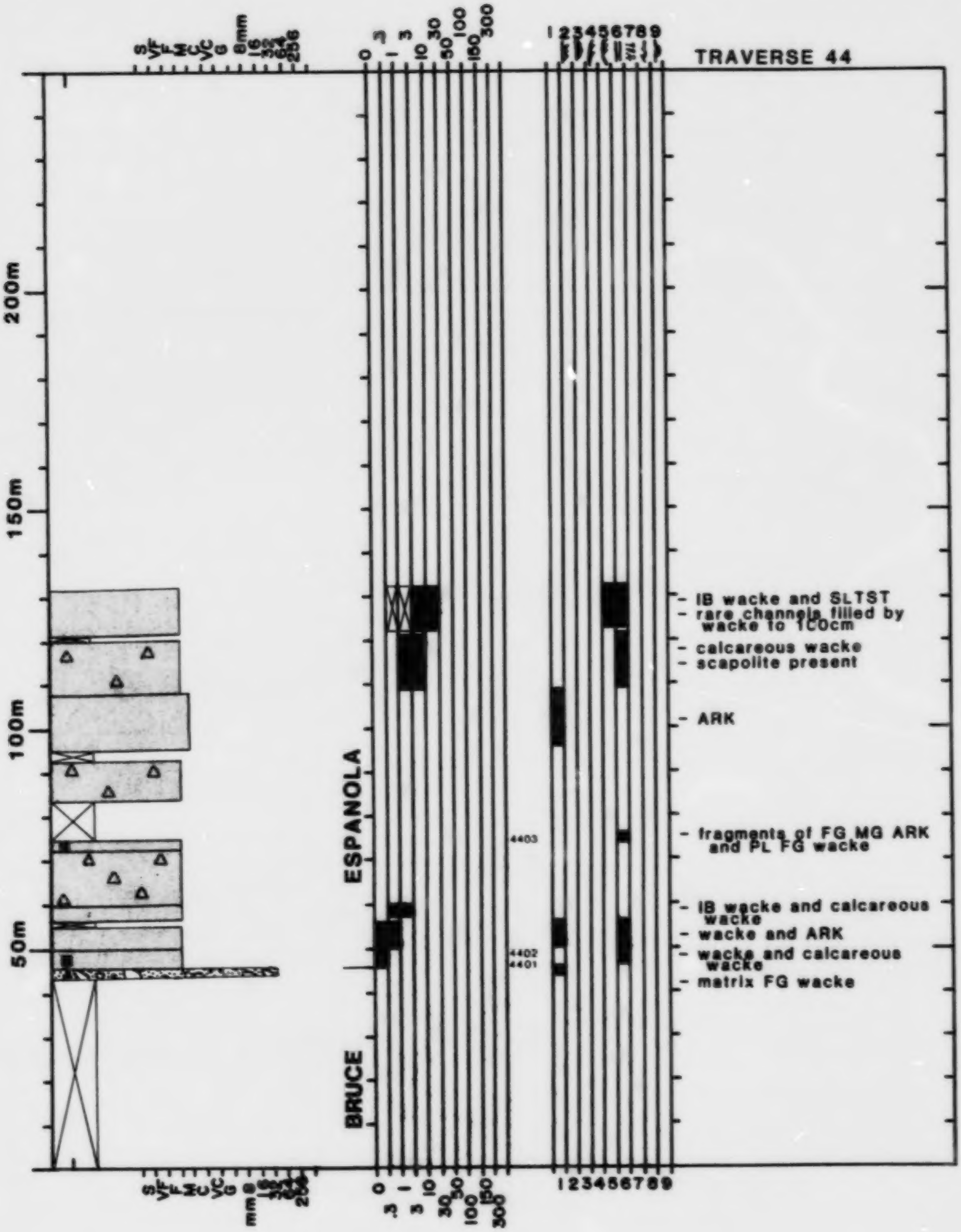
This section disrupted by several faults of uncertain displacement

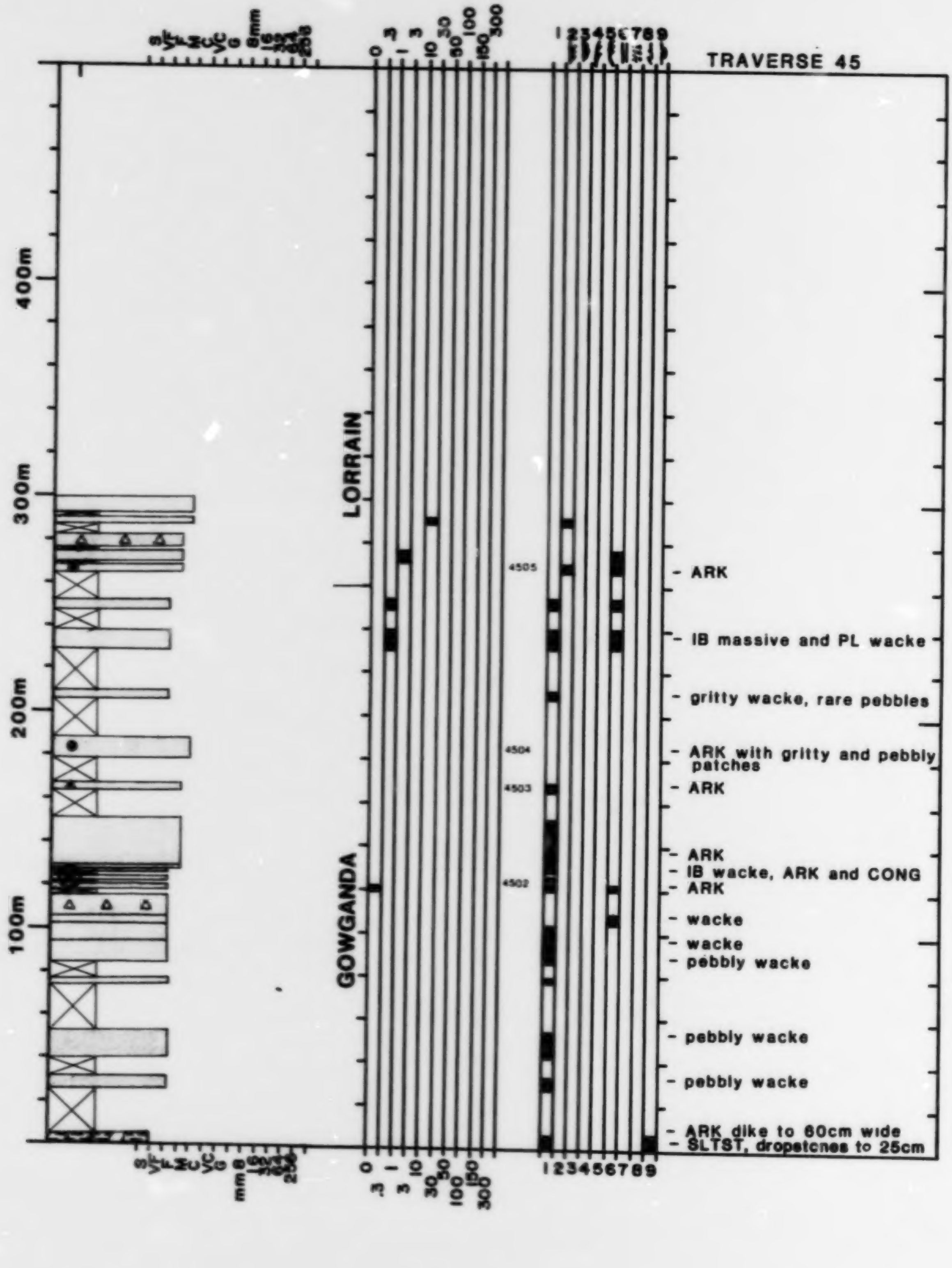

TRAVERSE 41, p.2
1000m
900m
800m
700m
600m
500m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
MISSISSAGI
4201
DC IB wacke to 6cm
SC MR
IB SLTST to FG wacke
SC MR to 15cm
IB ARK and silty wacke
IB wacke
SC MR to 8cm
pebbly sandstone dike 50cm wide
IB silty wacke
IB silty wacke
ripples in wacke
IB silty wacke
BCS
SC MR

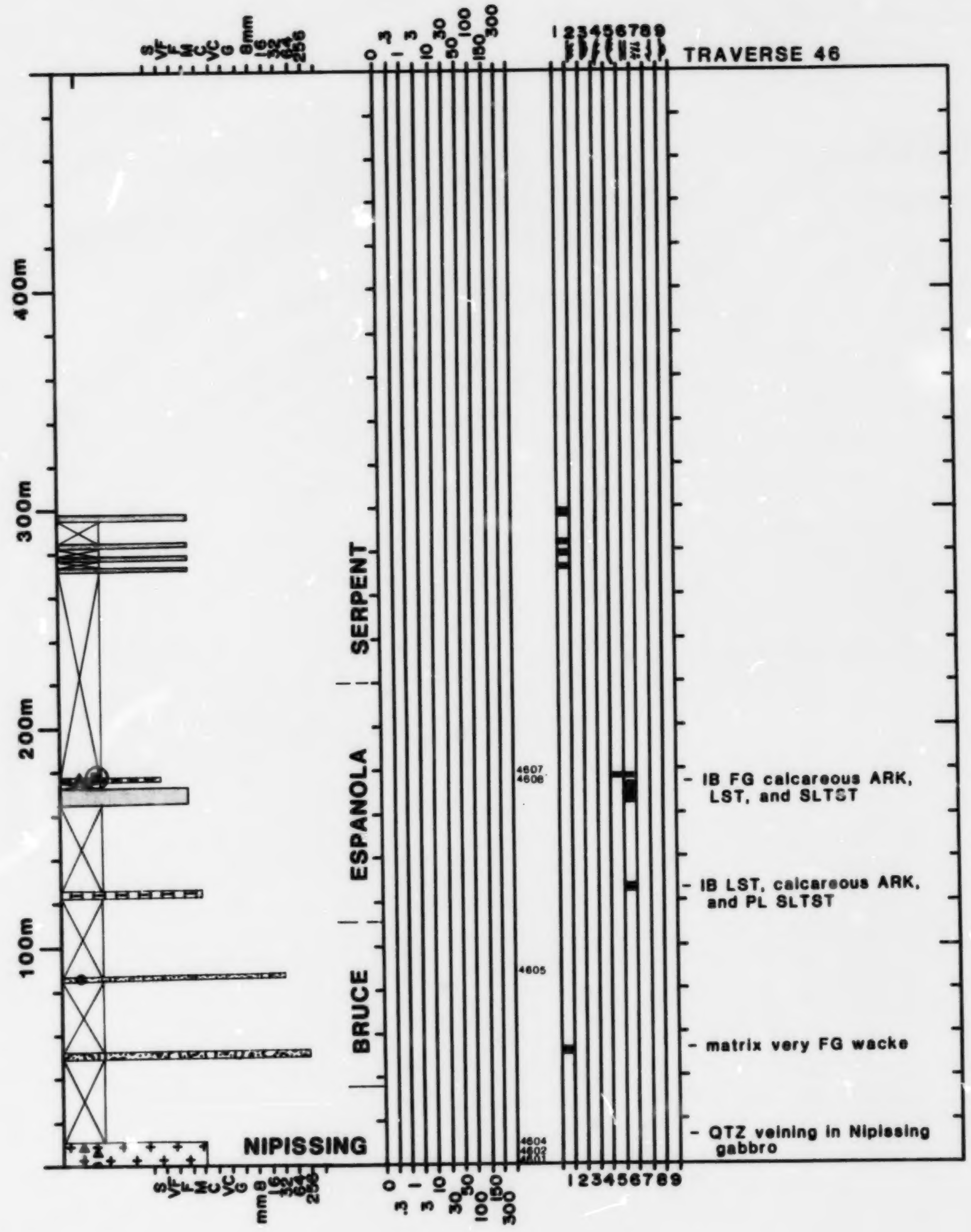

TRAVERSE 41, p.3
MISSISSAGI
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
- IB silty wacke and SUBARK
- fault
- DC IB SLTST
- few DC IB SLTST beds
- few DC IB SLTST beds
- few DC IB SLTST beds
- SC MR
- DC IB SLTST
- DC IB SLTST
- DC IB SLTST
- fault
- DC IB FG wacke
- some BCS
- fault
- ARK with IB silty wacke
- some BCS

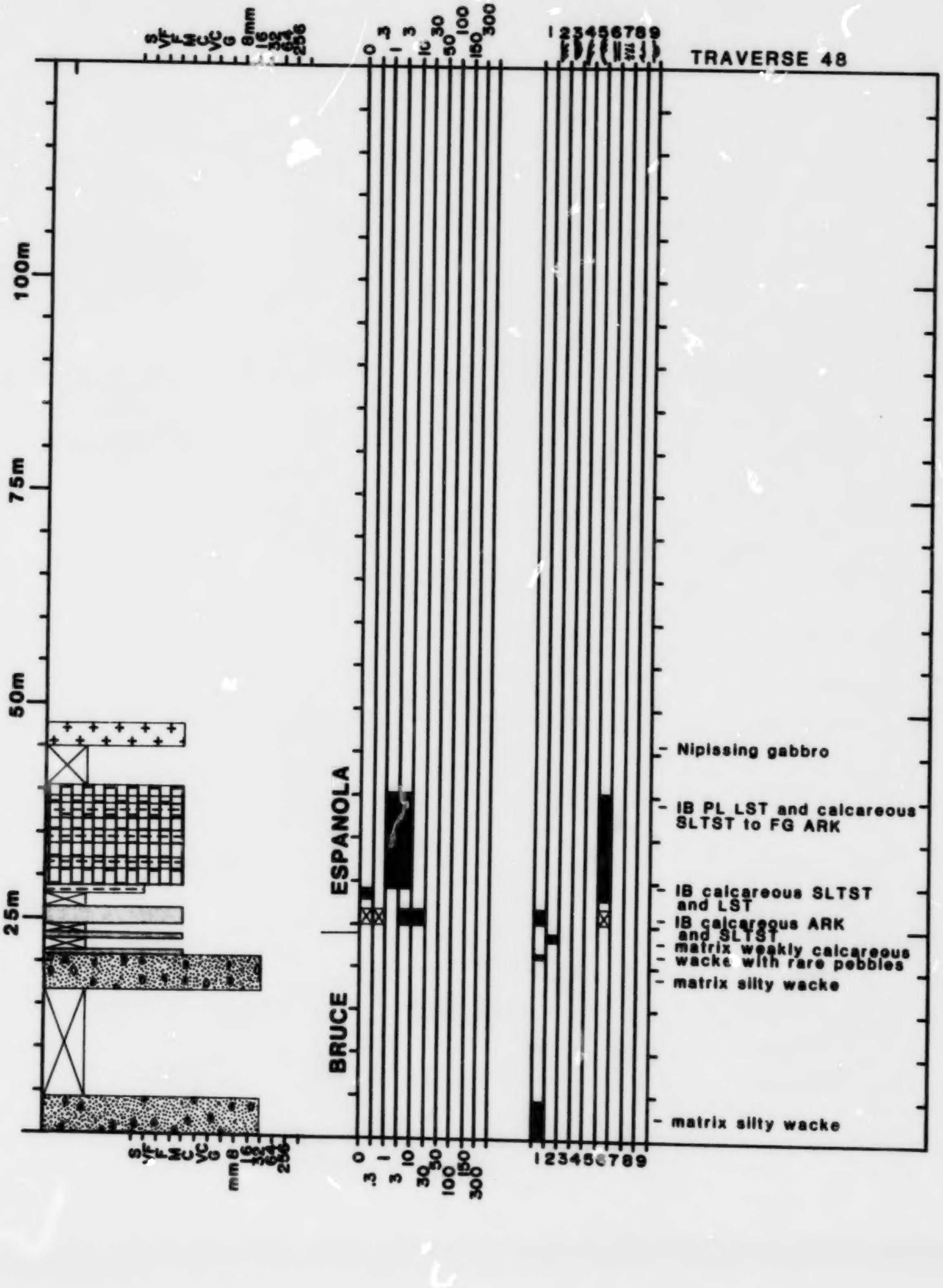

TRAVERSE 42-43, p1.
1000m
900m
800m
700m
600m
500m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
BRUCE
TRAVERSE 43
TRAVERSE 42
4207
- 5% CG QTZ and feldspar in silty wacke matrix
- DC IB FG ARK with minor IB gritty wacke in massive polymictic paraconglomerate
- 5% CG QTZ in silty wacke matrix
- rare clasts to 50cm
- as 604-626m
- matrix FG wacke with 5% CG QTZ and feldspar
- rare clasts to 100cm
- rare irregular clasts of ARK to 50×100cm
- matrix FG wacke with 15% angular CG clear grey QTZ
- few IB wacke horizons
- matrix wacke with 10% CG clear grey QTZ

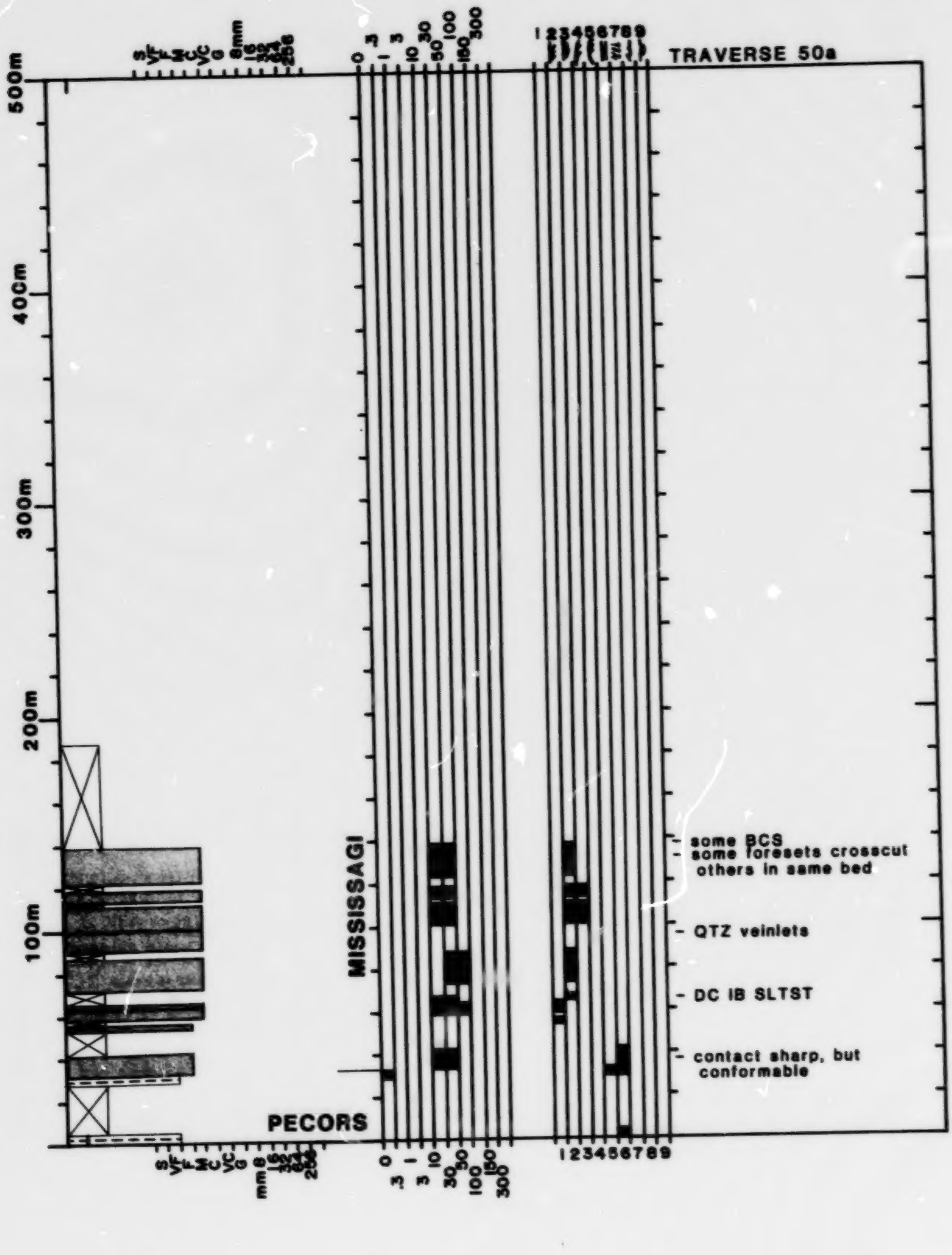

TRAVERSE 42-43, p2.
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
BRUCE
MISSISSAGI
TRAVERSE 42
4206
4204
4205
4203
4201
- few DC IB ARK and SLTST
- pebbly wacke, lower contact gradational
- wacke
- PL SUBARK
- matrix FG wacke
- most clasts 1cm, dropstones to 15cm
- pebbly wacke
- IB FG and MG wacke
- parallel bedding, poorly defined
- most clasts ≈ 1cm
- coarser-grained clear grey QTZ common in matrix
- most clasts≈1cm
- rare concentrations of pebbles
- rare concentrations of pebbles
- pebbly wacke
- IB FG wacke, MG SUBARK
- contacts gradational


TRAVERSE 44
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 5 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
200m
150m
100m
50m
ESPANOLA
BRUCE
4403
4402
4401
IB wacke and SLTST
rare channels filled by wacke to 100cm
calcareous wacke
scapolite present
ARK
fragments of FG MG ARK and PL FG wacke
IB wacke and calcareous wacke
wacke and ARK
wacke and calcareous wacke
matrix FG wacke

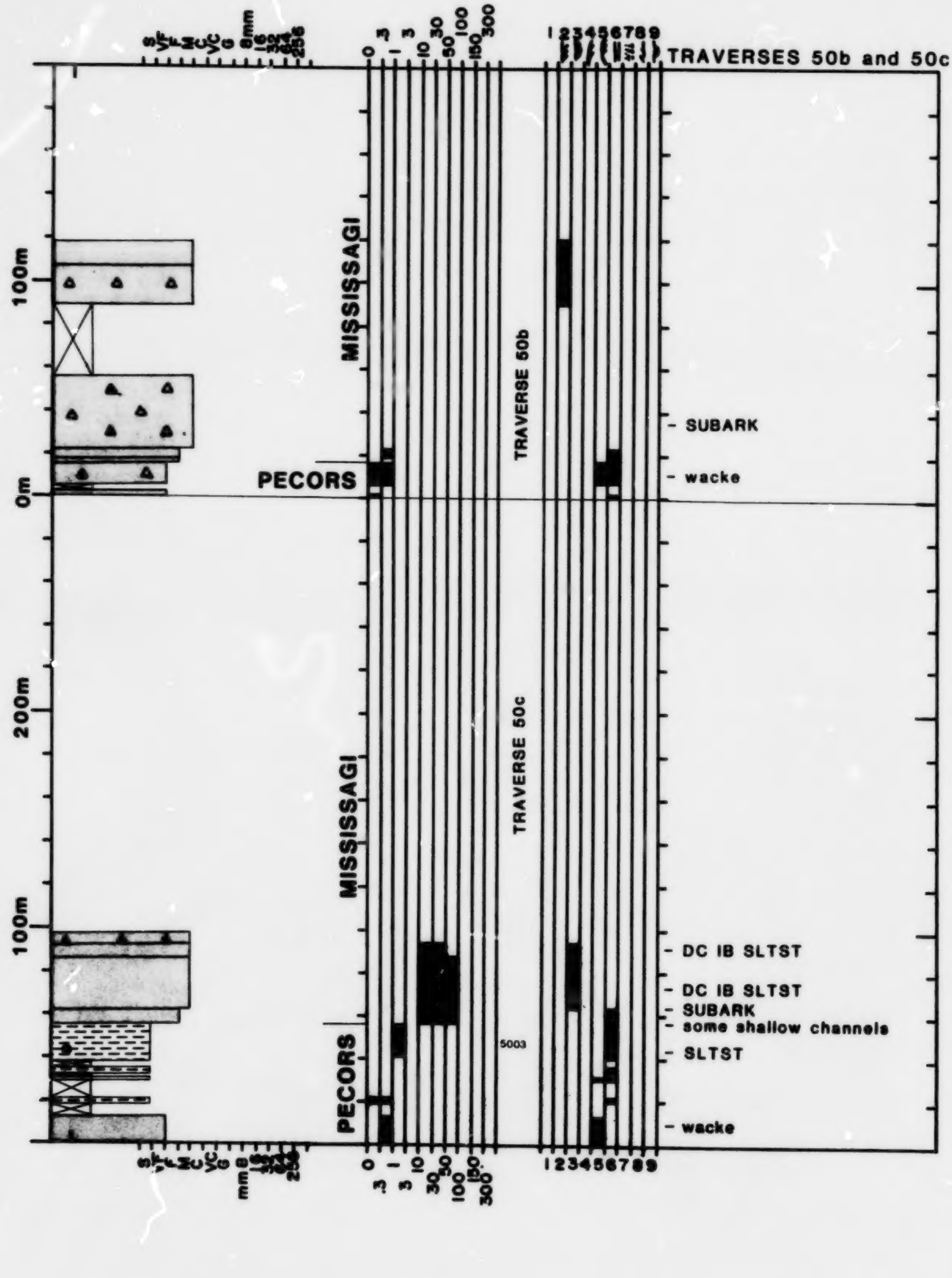

TRAVERSE 45
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
LORRAIN
GOWGANDA
4505
4504
4503
4502
- ARK
- IB massive and PL wacke
- gritty wacke, rare pebbles
- ARK with gritty and pebbly patches
- ARK
- ARK
- IB wacke, ARK and CONG
- ARK
- wacke
- wacke
- pebbly wacke
- pebbly wacke
- pebbly wacke
- ARK dike to 60cm wide
- SLTST, dropstones to 25cm

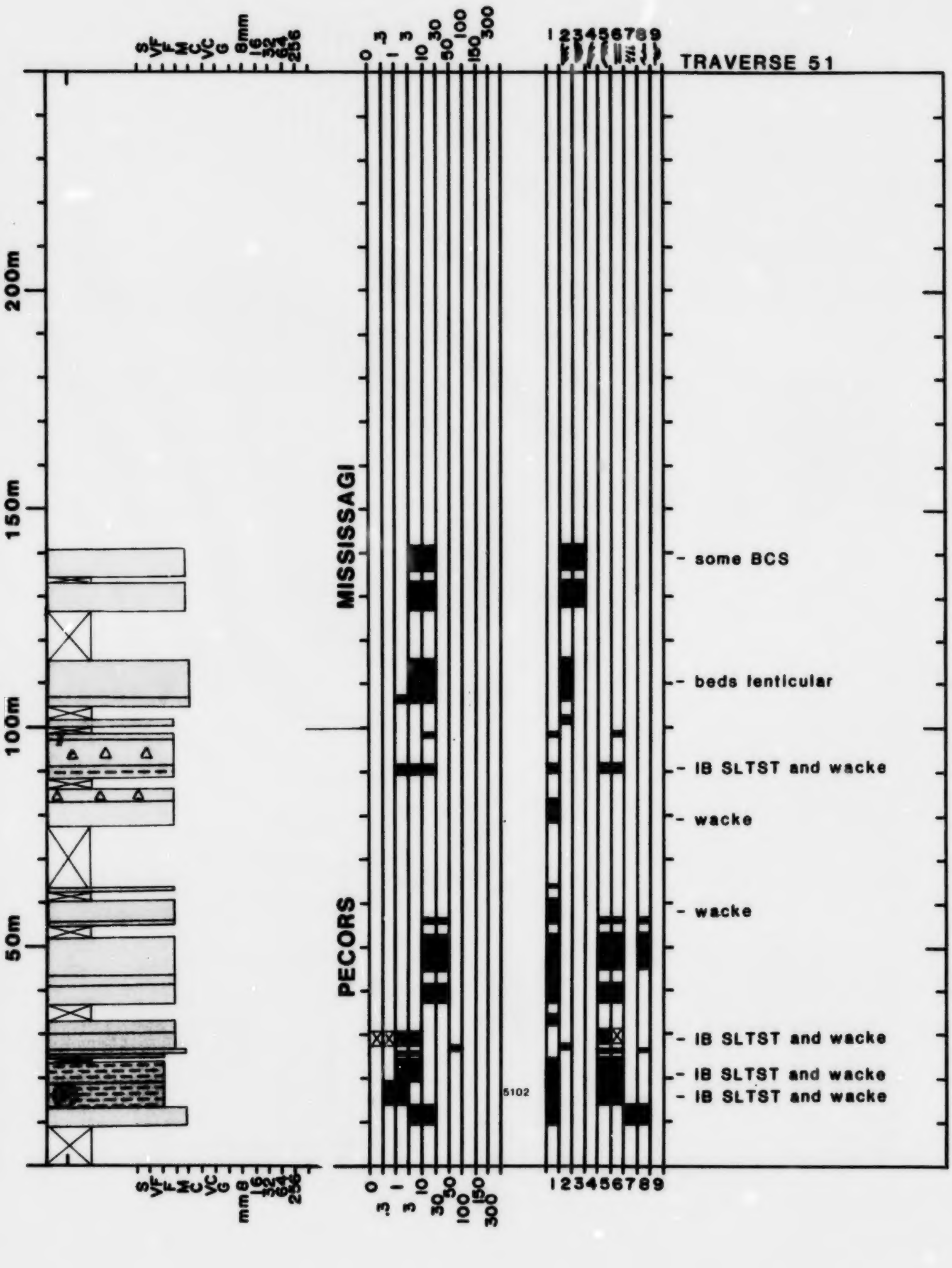

TRAVERSE 46
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
SERPENT
ESPANOLA
BRUCE
NIPISSING
4607
4606
4605
4604
4602
4601
- IB FG calcareous ARK, LST, and SLTST
- IB LST, calcareous ARK, and PL SLTST
- matrix very FG wacke
- QTZ veining in Nipissing gabbro

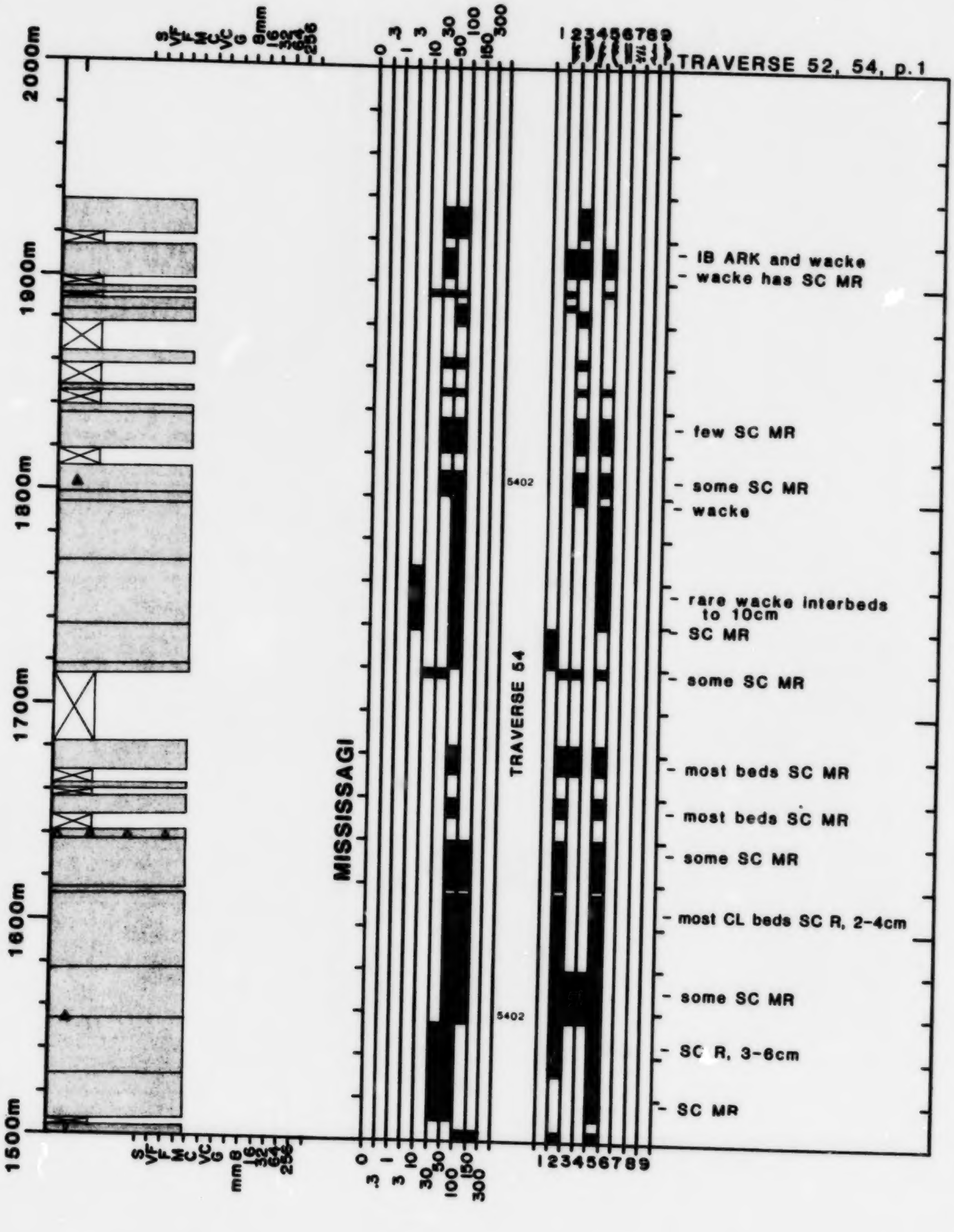

TRAVERSE 48
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
100m
75m
50m
25m
ESPANOLA
BRUCE
Nipissing gabbro
IB PL LST and calcareous SLTST to FG ARK
IB calcareous SLTST and LST
IB calcareous ARK and SLTST
matrix weakly calcareous
wacke with rare pebbles
matrix silty wacke
matrix silty wacke

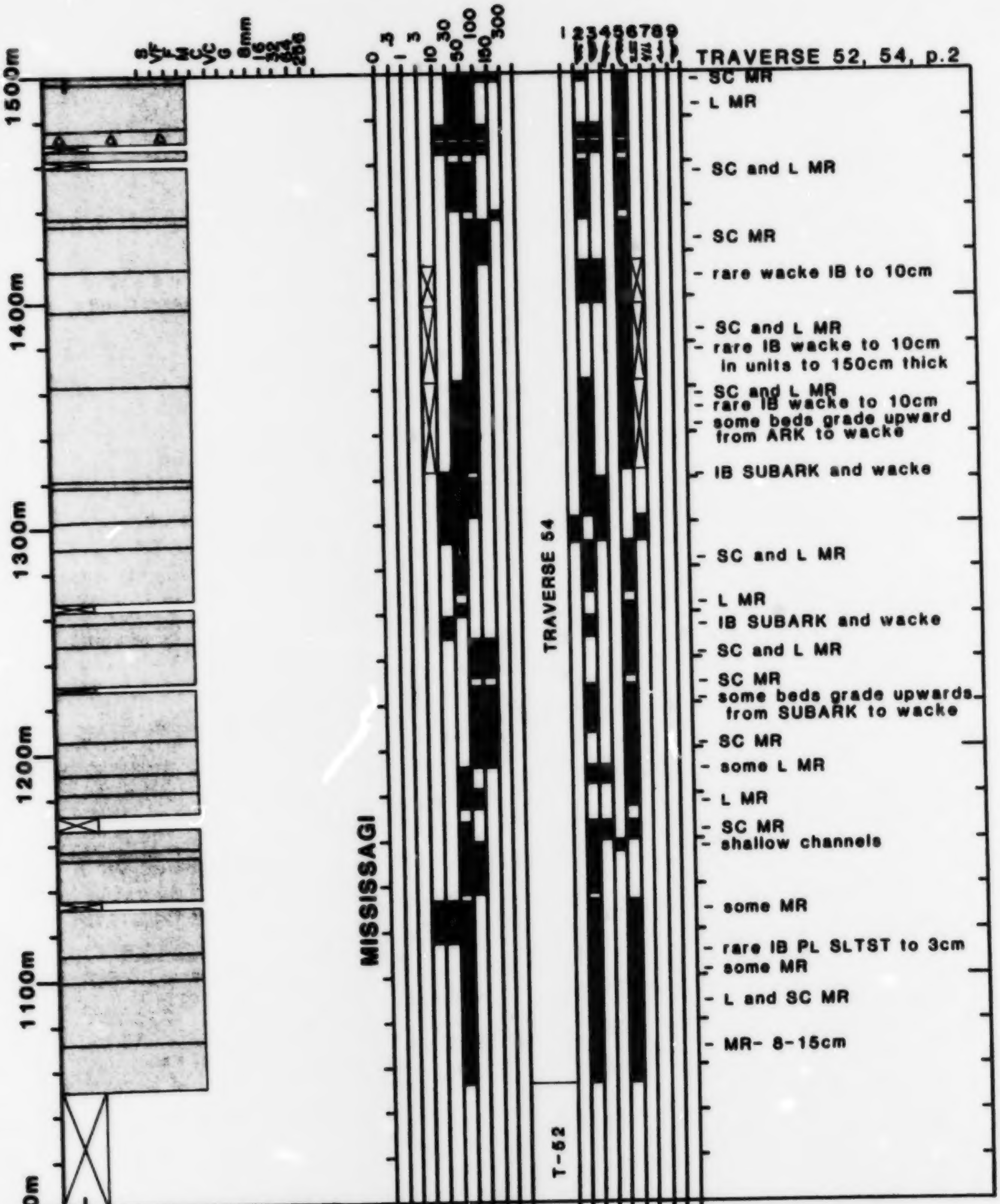


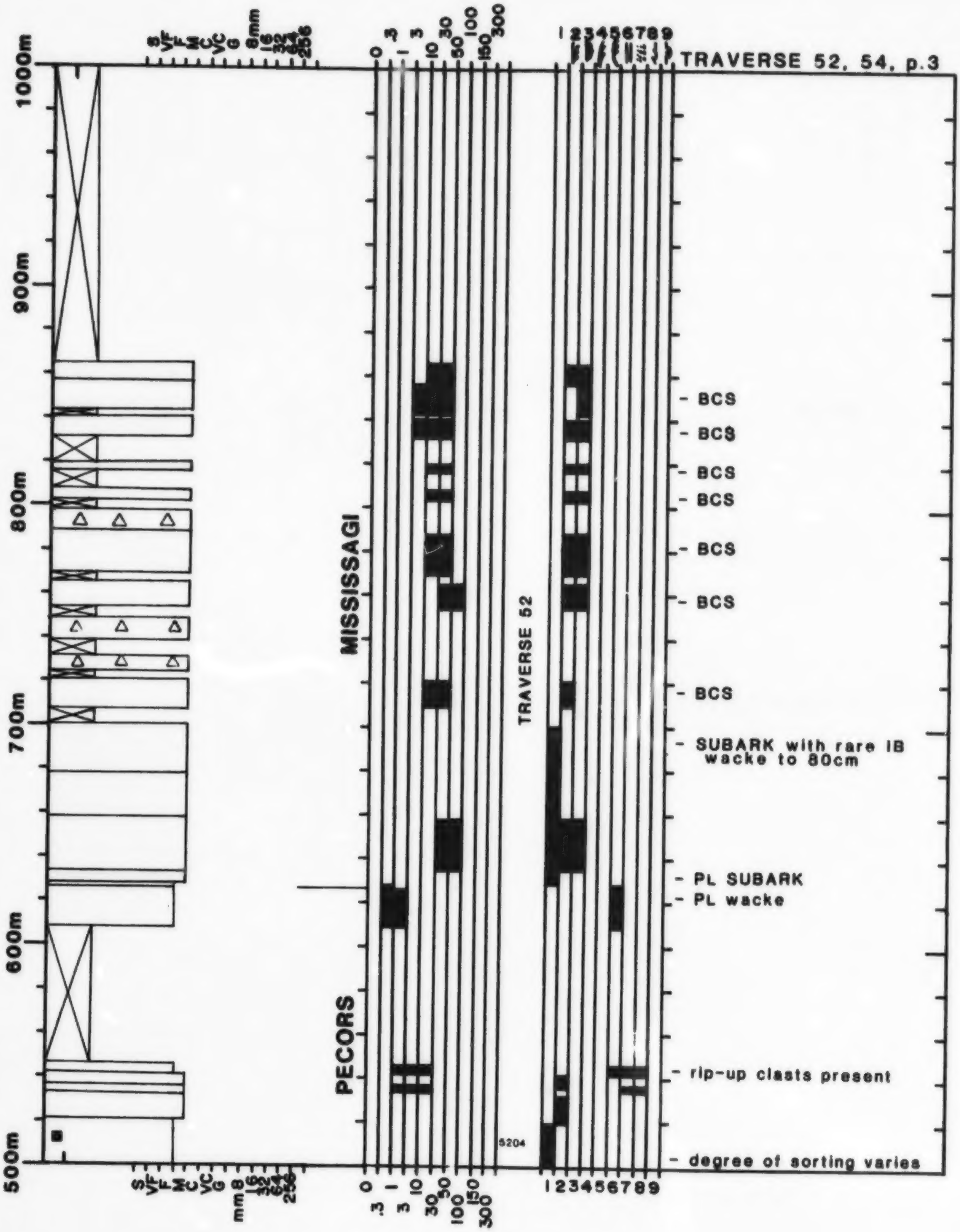
- some BCS
- some foresets crosscut others in same bed
- QTZ veinlets
- DC IB SLTST
- contact sharp, but conformable

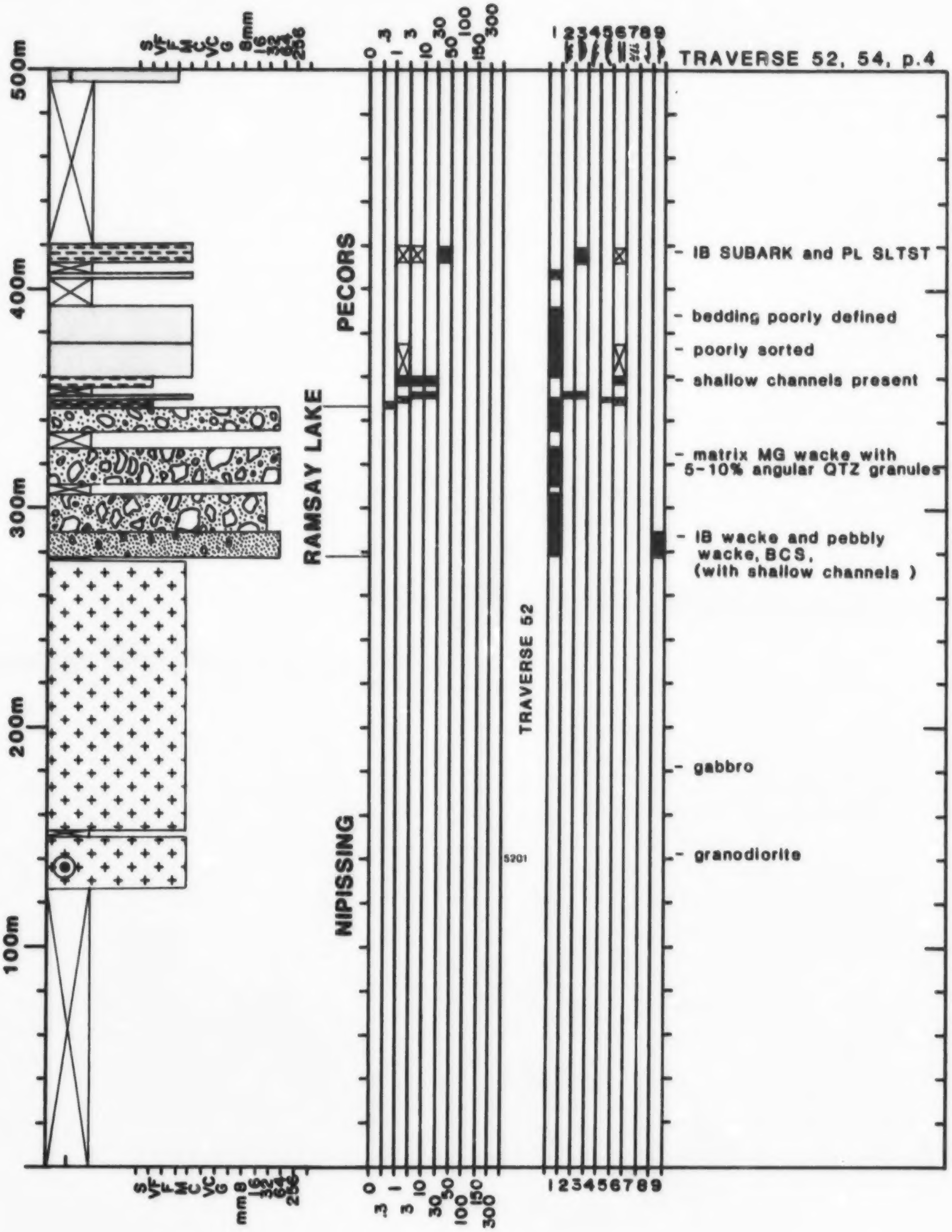

TRAVERSES 50b and 50c
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
100m
0m
200m
100m
MISSISSAGI
PECORS
TRAVERSE 50b
MISSISSAGI
PECORS
TRAVERSE 50c
5003
- SUBARK
- wacke
- DC IB SLTST
- DC IB SLTST
- SUBARK
- some shallow channels
- SLTST
- wacke

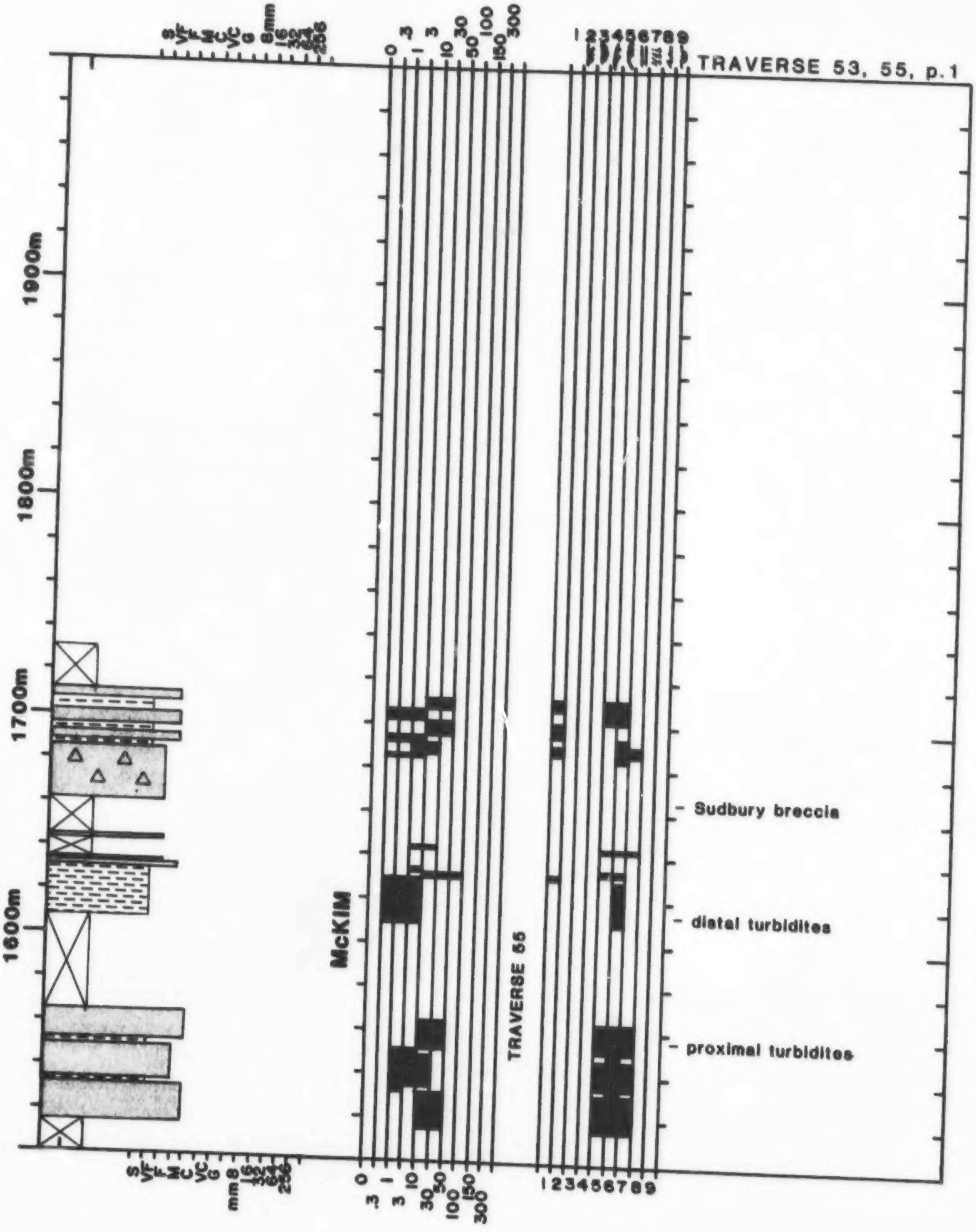

TRAVERSE 51
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
200m
150m
100m
50m
MISSISSAGI
PECORS
5102
some BCS
beds lenticular
IB SLTST and wacke
wacke
wacke
IB SLTST and wacke
IB SLTST and wacke
IB SLTST and wacke
S VF F M C VC G mm 8 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9

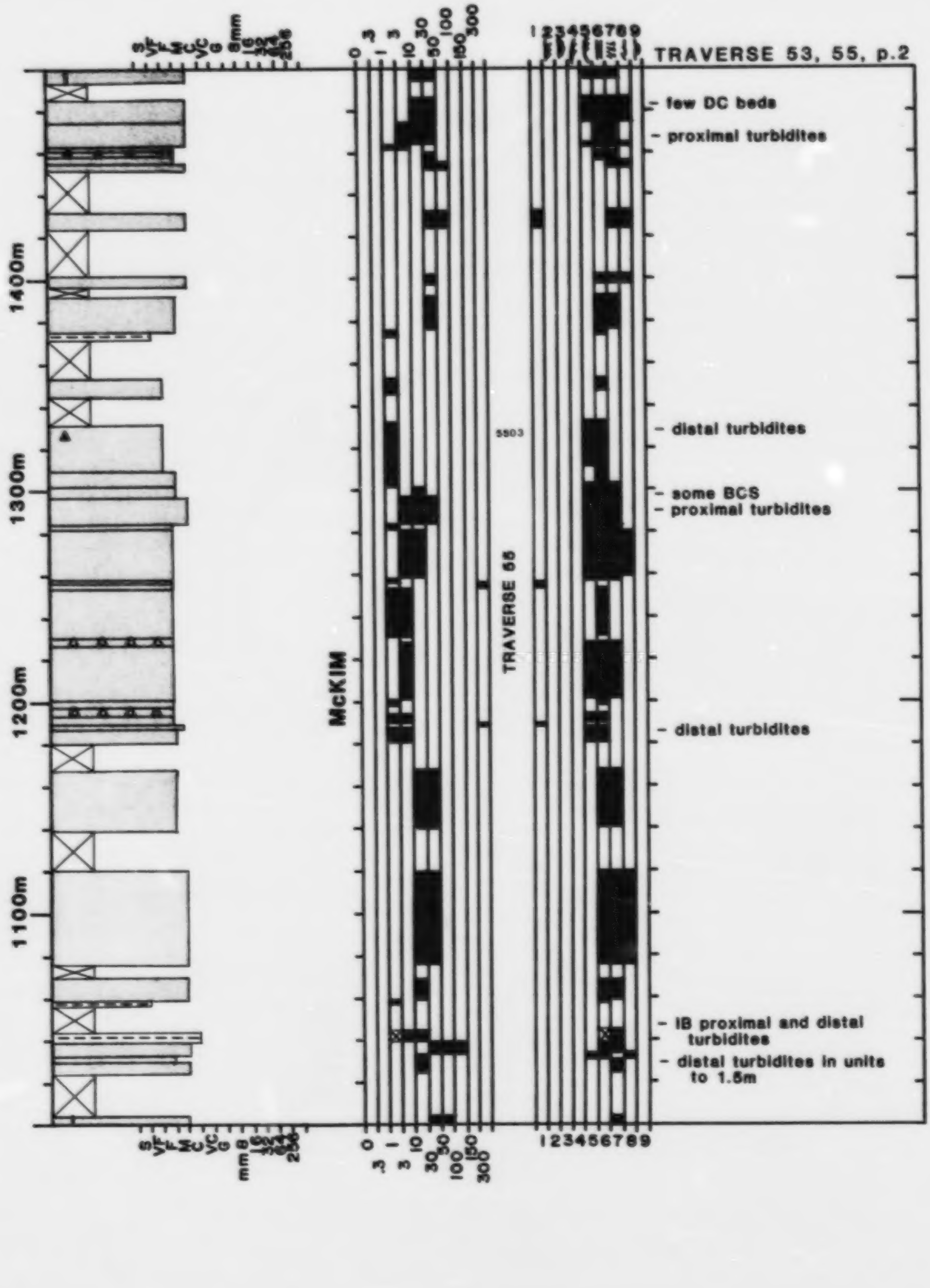

TRAVERSE 52, 54, p.1
2000m
1900m
1800m
1700m
1600m
1500m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
TRAVERSE 54
5402
5402
- IB ARK and wacke
- wacke has SC MR
- few SC MR
- some SC MR
- wacke
- rare wacke interbeds to 10cm
- SC MR
- some SC MR
- most beds SC MR
- most beds SC MR
- some SC MR
- most CL beds SC R, 2-4cm
- some SC MR
- SC R, 3-6cm
- SC MR

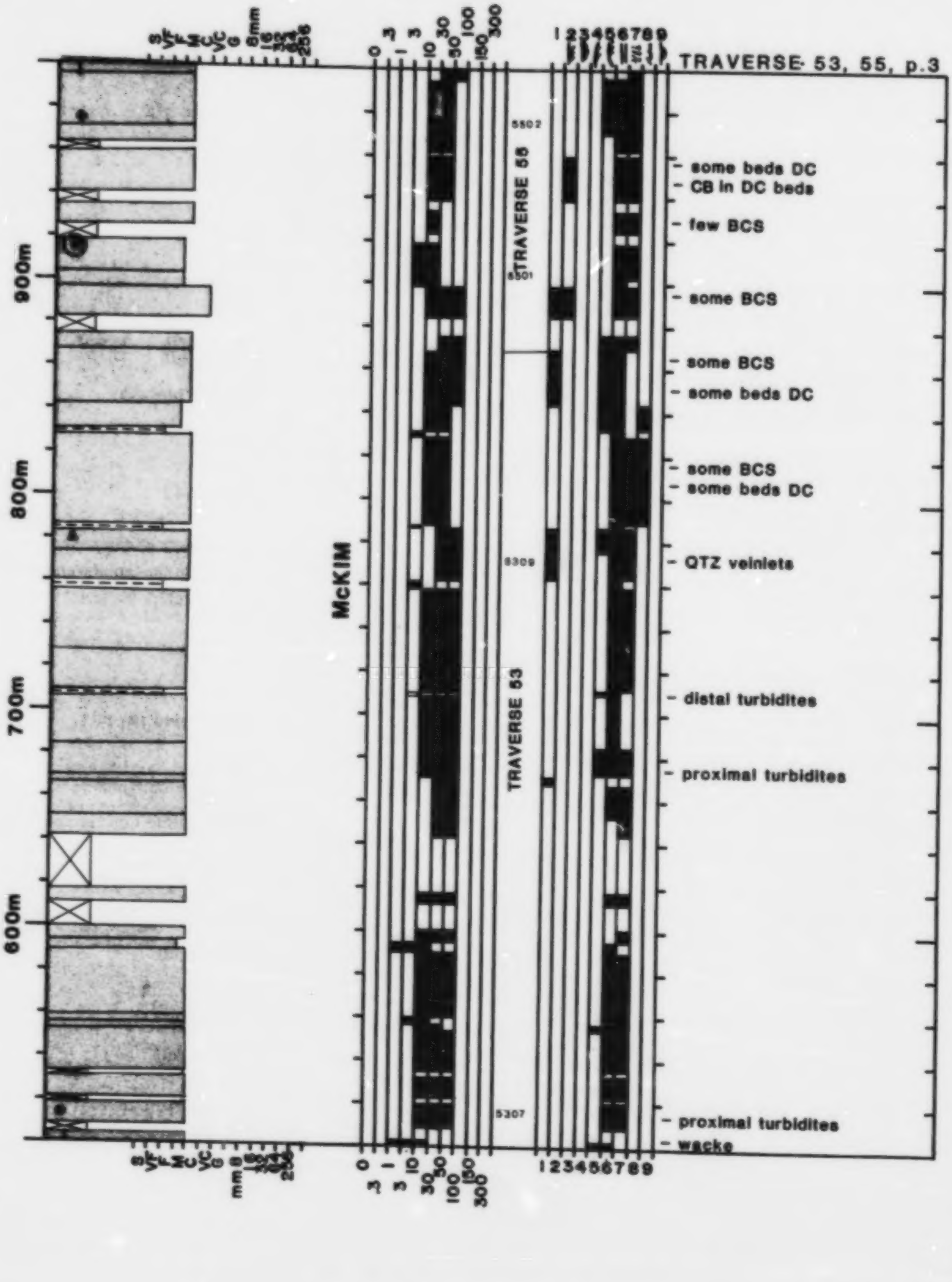

TRAVERSE 52, 54, p.2
1500m
1400m
1300m
1200m
1100m
1000m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
MISSISSAGI
TRAVERSE 54
T-52
- SC MR
- L MR
- SC and L MR
- SC MR
- rare wacke IB to 10cm
- SC and L MR
- rare IB wacke to 10cm in units to 150cm thick
- SC and L MR
- rare IB wacke to 10cm
- some beds grade upward from ARK to wacke
- IB SUBARK and wacke
- SC and L MR
- L MR
- IB SUBARK and wacke
- SC and L MR
- SC MR
- some beds grade upwards from SUBARK to wacke
- SC MR
- some L MR
- L MR
- SC MR
- shallow channels
- some MR
- rare IB PL SLTST to 3cm
- some MR
- L and SC MR
- MR- 8-15cm

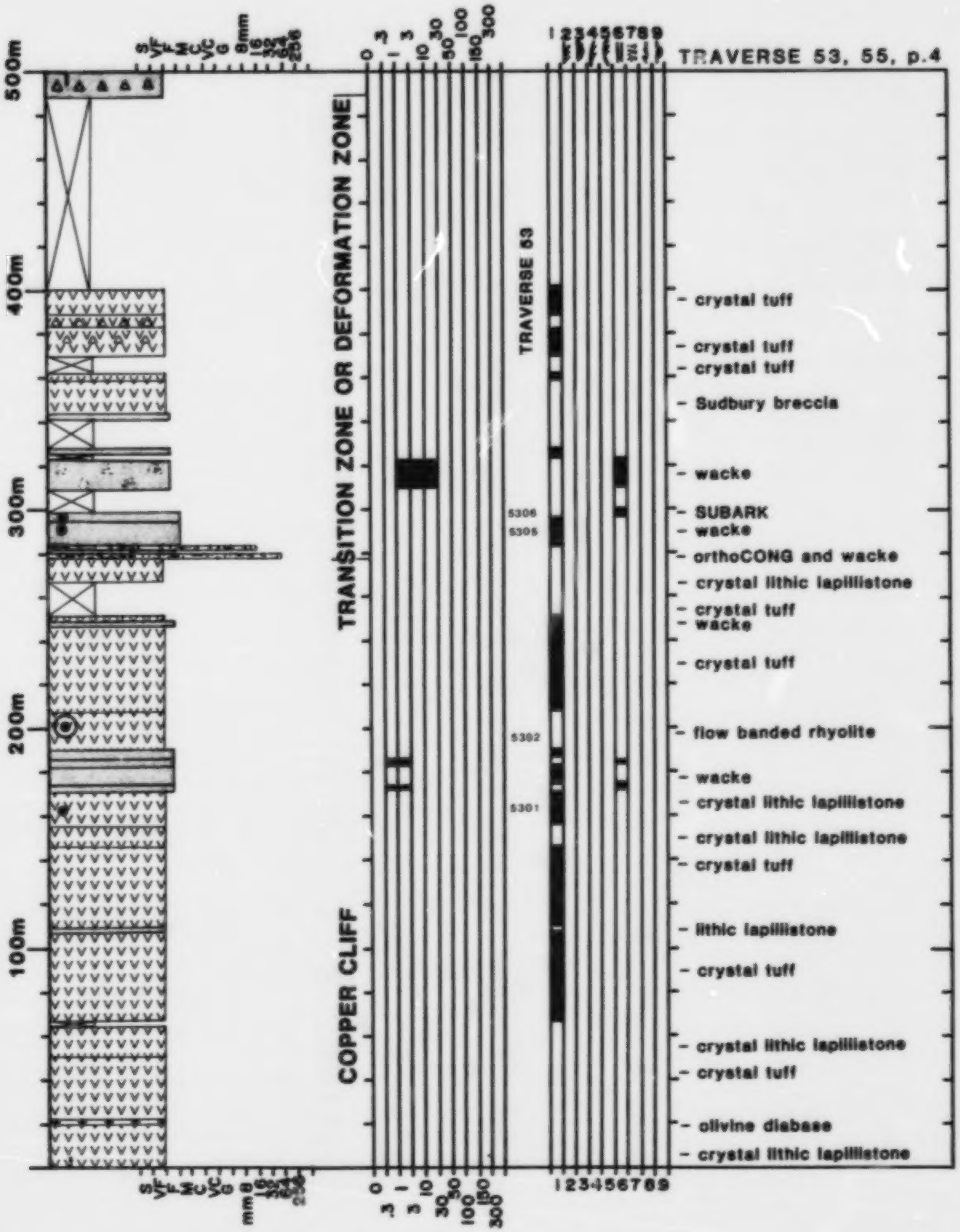

TRAVERSE 52, 54, p.3
1000m
900m
800m
700m
600m
500m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
MISSISSAGI
PECORS
TRAVERSE 52
- BCS
- BCS
- BCS
- BCS
- BCS
- BCS
- BCS
- SUBARK with rare IB wacke to 80cm
- PL SUBARK
- PL wacke
- rip-up clasts present
- degree of sorting varies
5204

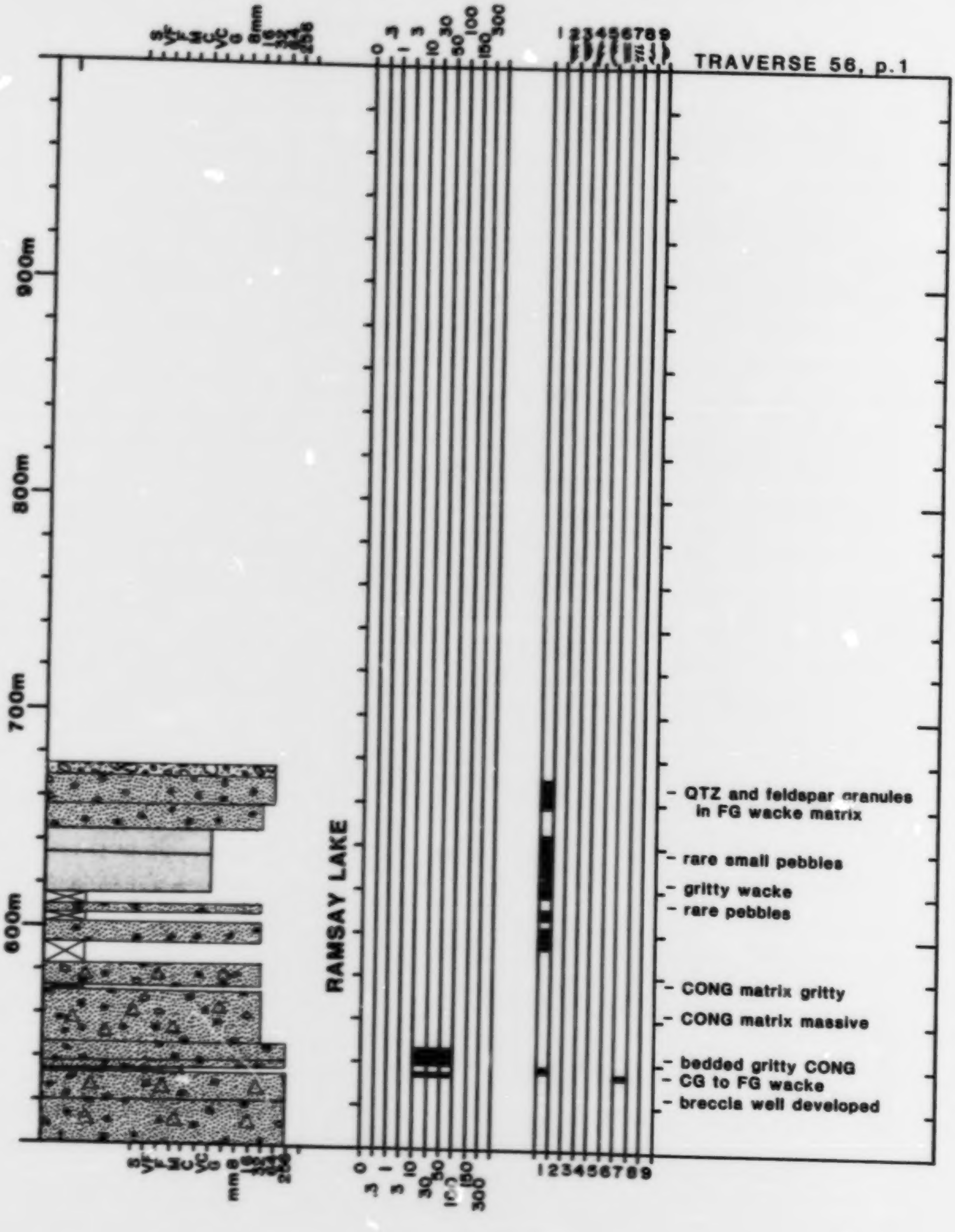

TRAVERSE 52, 54, p.4
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
PECORS
RAMSAY LAKE
NIPISSING
TRAVERSE 52
5201
- IB SUBARK and PL SLTST
- bedding poorly defined
- poorly sorted
- shallow channels present
- matrix MG wacke with 5-10% angular QTZ granules
- IB wacke and pebbly wacke, BCS, (with shallow channels)
- gabbro
- granodiorite

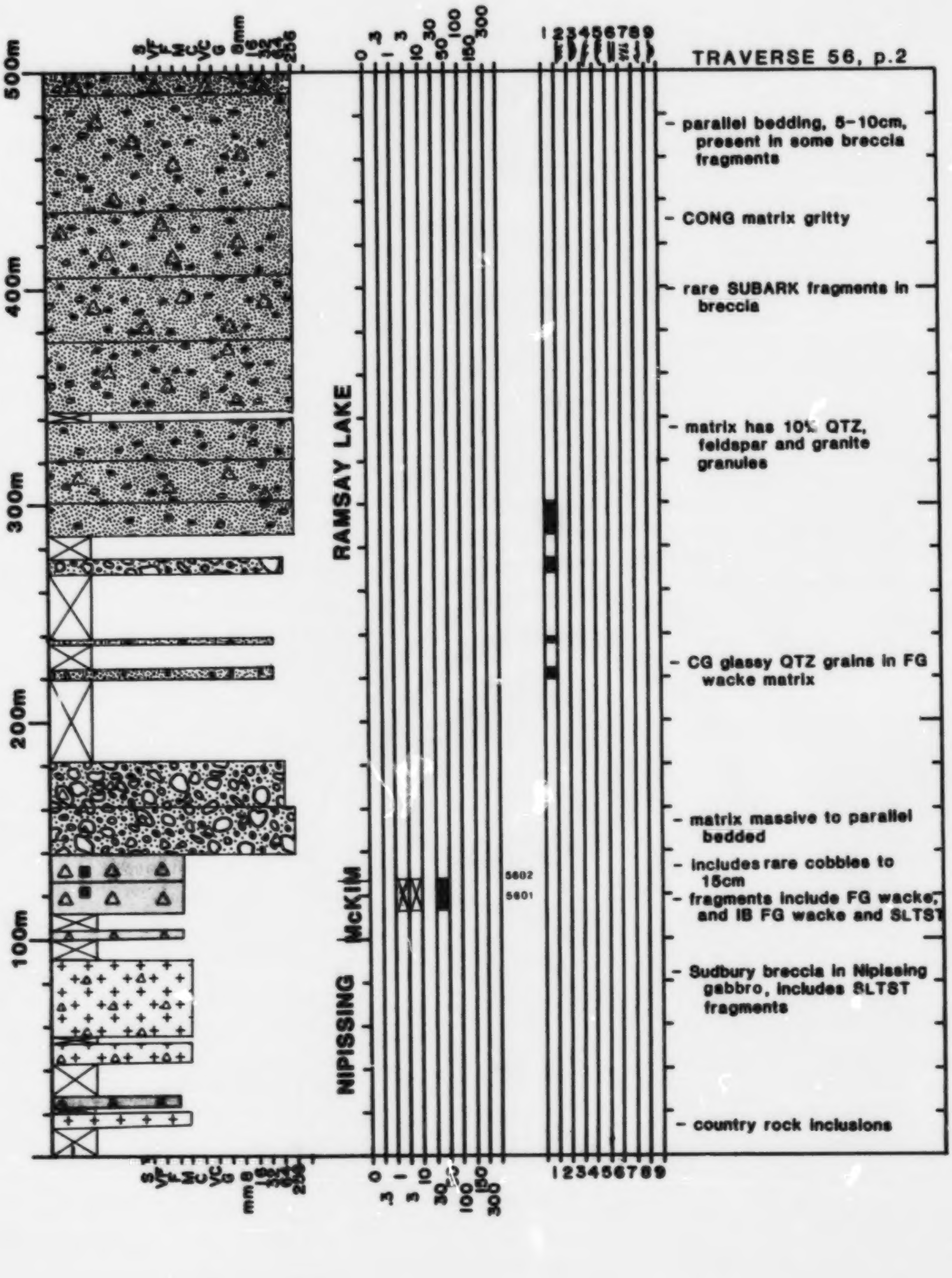

TRAVERSE 53, 55, p.1
1900m
1800m
1700m
1600m
S VF F M C VC G
mm 8 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
McKIM
TRAVERSE 55
Sudbury breccia
distal turbidites
proximal turbidites

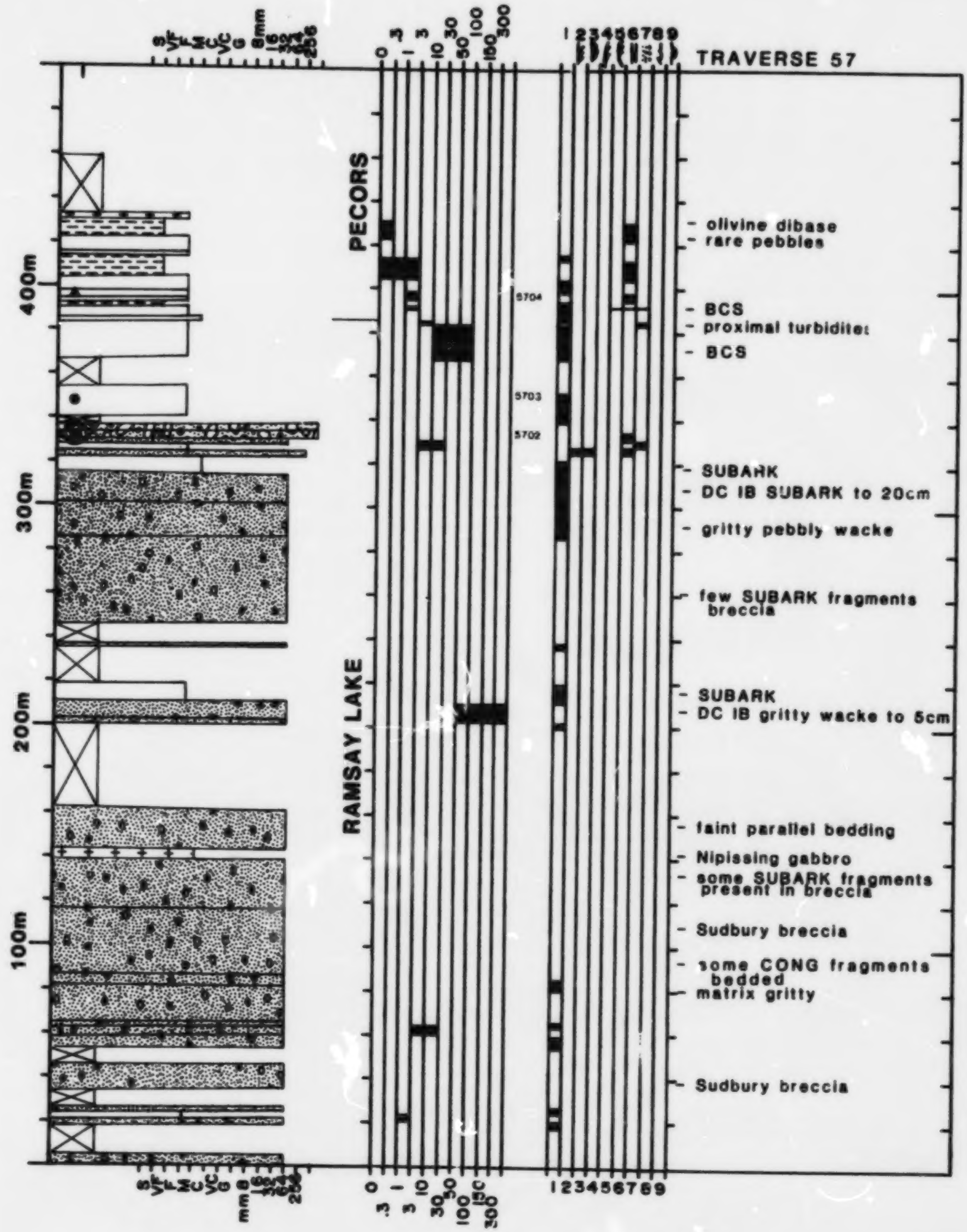

TRAVERSE 53, 55, p.2
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
- few DC beds
- proximal turbidites
- distal turbidites
- some BCS
- proximal turbidites
- distal turbidites
- IB proximal and distal turbidites
- distal turbidites in units to 1.5m
1400m
1300m
1200m
1100m
McKIM
TRAVERSE 55
5503

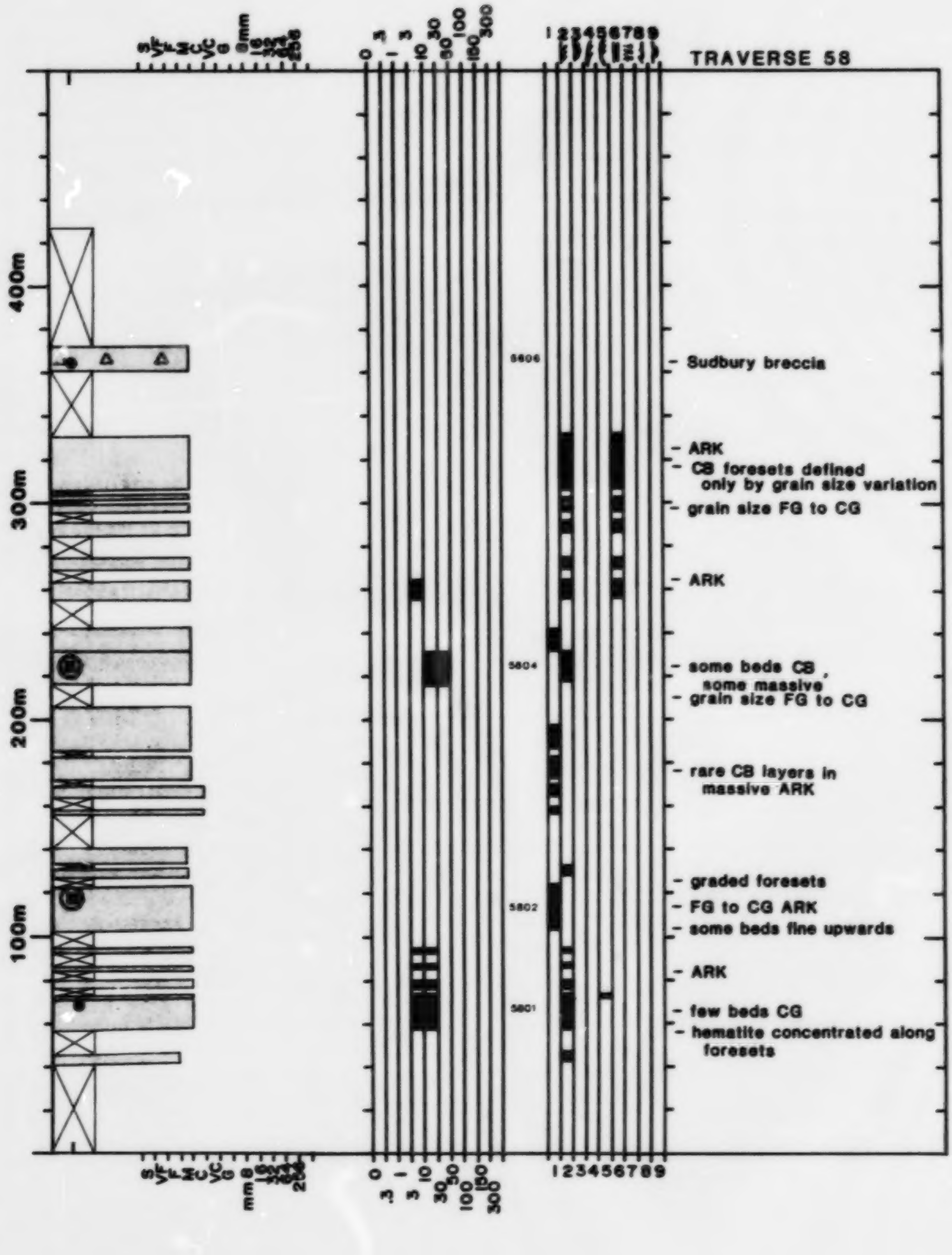

TRAVERSE 53, 55, p.3
some beds DC
CB in DC beds
few BCS
some BCS
some BCS
some beds DC
some BCS
some beds DC
QTZ veinlets
distal turbidites
proximal turbidites
proximal turbidites
wacke
McKIM
TRAVERSE 55
TRAVERSE 53
900m
800m
700m
600m
5502
5501
5309
5307
S VF F M C VC G 8mm 16 32 64 128 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9

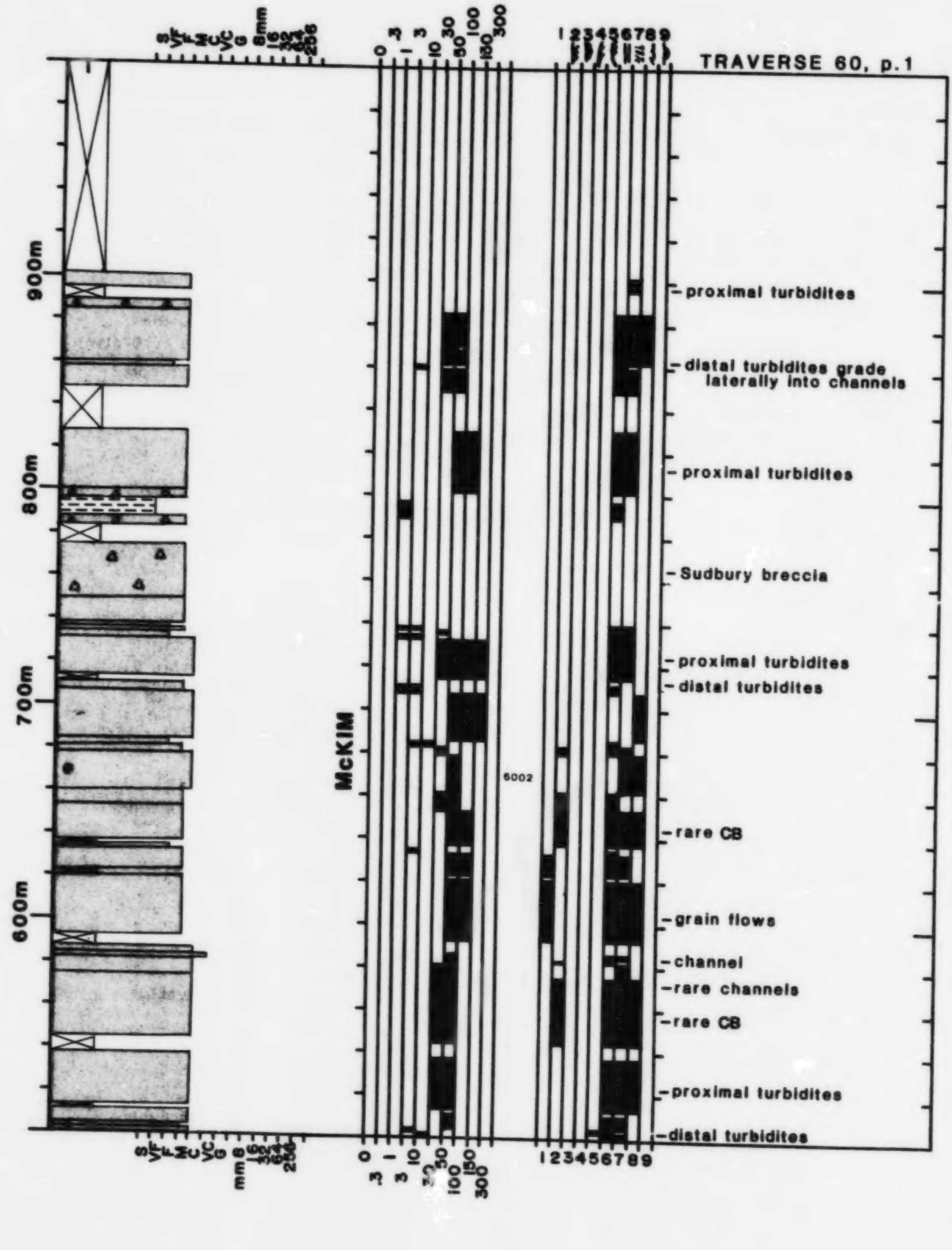

TRAVERSE 53, 55, p.4
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
123456789
TRANSITION ZONE OR DEFORMATION ZONE
COPPER CLIFF
TRAVERSE 53
5306
5305
5302
5301
crystal tuff
crystal tuff
crystal tuff
Sudbury breccia
wacke
SUBARK
wacke
orthoCONG and wacke
crystal lithic lapillistone
crystal tuff
wacke
crystal tuff
flow banded rhyolite
wacke
crystal lithic lapillistone
crystal lithic lapillistone
crystal tuff
lithic lapillistone
crystal tuff
crystal lithic lapillistone
crystal tuff
olivine diabase
crystal lithic lapillistone

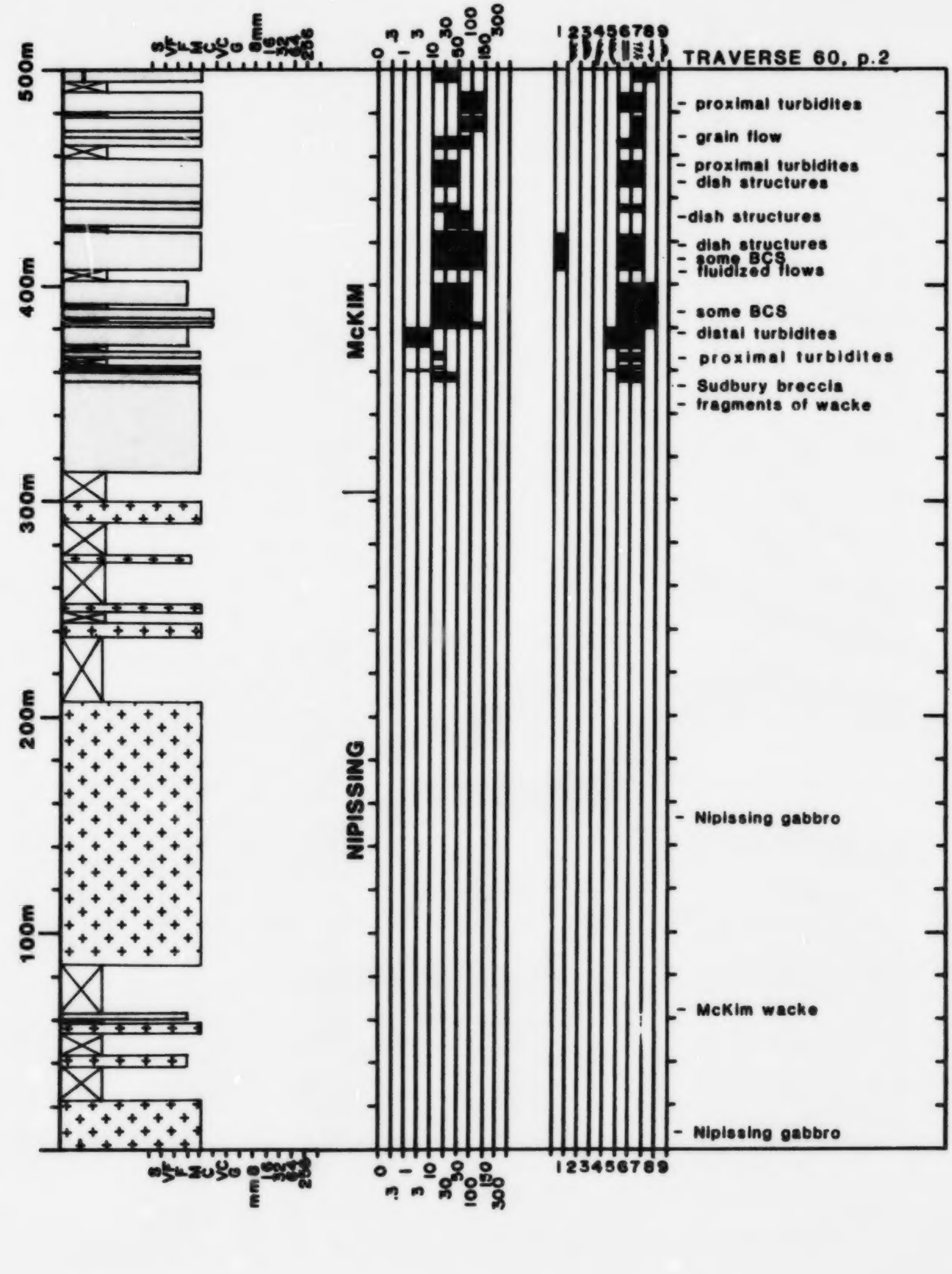

TRAVERSE 56, p.1
900m
800m
700m
600m
RAMSAY LAKE
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
QTZ and feldspar granules in FG wacke matrix
rare small pebbles
gritty wacke
rare pebbles
CONG matrix gritty
CONG matrix massive
bedded gritty CONG
CG to FG wacke
breccia well developed


TRAVERSE 56, p.2
500m
400m
300m
200m
100m
s VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
RAMSAY LAKE
McKIM
NIPISSING
5602
5601
- parallel bedding, 5-10cm, present in some breccia fragments
- CONG matrix gritty
- rare SUBARK fragments in breccia
- matrix has 10% QTZ, feldspar and granite granules
- CG glassy QTZ grains in FG wacke matrix
- matrix massive to parallel bedded
- includes rare cobbles to 15cm
- fragments include FG wacke, and IB FG wacke and SLTST
- Sudbury breccia in Nipissing gabbro, includes SLTST fragments
- country rock inclusions


TRAVERSE 57
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
400m
300m
200m
100m
PECORS
RAMSAY LAKE
5704
5703
5702
olivine dibase
rare pebbles
BCS
proximal turbidites
BCS
SUBARK
DC IB SUBARK to 20cm
gritty pebbly wacke
few SUBARK fragments
breccia
SUBARK
DC IB gritty wacke to 5cm
faint parallel bedding
Nipissing gabbro
some SUBARK fragments present in breccia
Sudbury breccia
some CONG fragments
bedded
matrix gritty
Sudbury breccia


TRAVERSE 58
400m
300m
200m
100m
S VF F M C VC G
mm 8 16 32 64 128 256
0 .3 1 3 5 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
5806
5804
5802
5801
Sudbury breccia
ARK
CB foresets defined only by grain size variation
grain size FG to CG
ARK
some beds CB, some massive
grain size FG to CG
rare CB layers in massive ARK
graded foresets
FG to CG ARK
some beds fine upwards
ARK
few beds CG
hematite concentrated along foresets


TRAVERSE 60, p.1
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
900m
800m
700m
600m
McKIM
6002
proximal turbidites
distal turbidites grade laterally into channels
proximal turbidites
Sudbury breccia
proximal turbidites
distal turbidites
rare CB
grain flows
channel
rare channels
rare CB
proximal turbidites
distal turbidites


TRAVERSE 60, p.2
500m
400m
300m
200m
100m
S VF F M C VC G 8mm 16 32 64 256
0 .3 1 3 10 30 50 100 150 300
1 2 3 4 5 6 7 8 9
McKIM
NIPISSING
- proximal turbidites
- grain flow
- proximal turbidites
- dish structures
-dish structures
- dish structures
- some BCS
- fluidized flows
- some BCS
- distal turbidites
- proximal turbidites
- Sudbury breccia
- fragments of wacke
- Nipissing gabbro
- McKim wacke
- Nipissing gabbro

Appendix 2 – Tables Listing Samples Having Modal, Whole Rock Geochemical and Trace Element Geochemical Analyses

TABLE 1. MODAL ANALYSES, ELLIOT LAKE GROUP: STOBIE AND COPPER CLIFF FORMATIONS.

	1	2	3	4	5	6
Quartz	1.8	–	28.4	7.0	41.6	47.5
Potassic Feldspar	7.4	–	10.8	5.8	33.4	17.7
Plagioclase	4.6	–	1.8	2.0	x	0.4
Lithic Fragments	35.4	–	–	–		
Matrix	85.4	94.6	–	84.6	–	–
Muscovite	0.6	–	21.2	0.2	21.2	26.4
Biotite	0.2	–	2.4	0.4	3.2	–
Chlorite	–	3.5	–	–	–	7.2
Augite	–	1.7	–	–	–	–
Opaque Minerals	–	0.2	–	–	0.6	0.8
An composition	nd	nd	nd	nd		

1. 86RLD-0203 Dacite (Stobie)
2. 86RLD-1901 Siltstone (Stobie)
3. 86RLD-5301 Rhyolitic crystal lithic lapillistone (Copper Cliff)
4. 86RLD-5302 Rhyolitic crystal tuff (Copper Cliff)
5. 86RLD-5305 Arkose to arkosic wacke (Copper Cliff)
6. 86RLD-5306 Arkose to arkosic wacke (Copper Cliff)

–: not detected
nd: not determined
x: trace amounts present

TABLE 2. MODAL ANALYSES, ELLIOT LAKE GROUP: MATINENDA AND McKIM FORMATIONS.

	1	2	3	4	5	6	7	8
Quartz	55.8	42.7	38.2	44.0	56.0	58.0	30.4	65.0
Potassic Feldspar	3.6	–	0.8	14.2	12.8	4.8	5.2	4.4
Plagioclase	0.2	0.1	1.6	0.6	0.4	0.4	0.2	1.0
Lithic Fragments	15.8	11.2	12.0	7.0	1.8	5.0	–	–
Matrix	22.8	44.0	42.2	20.6	15.6	22.2	40.6	15.0
Muscovite	–	0.2	–	–	1.2	–	20.8	–
Biotite	–	–	0.2	5.2	1.8	4.4	0.6	13.2
Chlorite	–	–	–	7.4	10.0	4.6	2.0	–
Opaque Minerals	1.8	1.8	5.0	1.0	0.4	0.6	0.2	1.4
Titanite	–	x	–	–	x	x	x	–
Sphene	–	–	–	–	–	x	–	–
An composition	nd	An_{36-54}	nd	An_{24}	An_{30-37}	An_{30-38}	An_{25-38}	An_{48}

1. 86RLD-2305 Sublithwacke (Matinenda)
2. 86RLD-2312 Sublithwacke (Matinenda)
3. 86RLD-2313 Sublithwacke (Matinenda)
4. 86RLD-5307 Feldspathic lithwacke (McKim)
5. 86RLD-5501 Lithic subarkosic wacke (McKim)
6. 86RLD-5502 Sublithwacke (McKim)
7. 86RLD-5601 Metasediment (McKim)
8. 86RLD-6002 Sublithwacke (McKim)

–: not detected
nd: not determined
x: trace amounts present

TABLE 3. WHOLE ROCK GEOCHEMICAL ANALYSES, ELLIOT LAKE GROUP: STOBIE, COPPER CLIFF AND McKIM FORMATIONS.

	Major Components in Weight Percent			
	a	**b**	**c**	**d**
SiO_2	70.0	46.0	76.0	85.7
Al_2O_3	12.3	17.6	12.1	6.53
Fe_2O_3	2.33	3.80	0.51	0.27
FeO	2.74	9.26	1.03	1.59
MgO	1.12	4.98	0.09	1.35
CaO	2.42	11.5	0.68	0.26
Na_2O	3.14	0.30	2.76	1.23
K_2O	2.83	0.16	5.27	0.59
TiO_2	0.61	0.98	0.19	0.24
P_2O_5	0.19	0.11	0.03	0.03
MnO	0.05	0.16	0.03	0.02
CO_2	0.23	0.84	0.34	0.28
S	0.01	0.03	0.02	0.04
H_2O^+	0.70	3.23	0.21	0.94
H_2O^-	0.07	0.09	0.06	0.11
Total	98.7	99.0	99.2	99.2
S.G.	2.73	3.08	nd	nd

a. 86RLD-0203 Dacite (Stobie)
b. 86RLD-1902 Basalt (Stobie)
c. 86RLD-5302 Rhyolitic crystal tuff (Copper Cliff)
d. 86RLD-5501 Wacke (McKim)
nd: not determined

TABLE 4. MODAL ANALYSES, HOUGH LAKE GROUP: RAMSAY LAKE, PECORS AND MISSISSAGI FORMATIONS.

	1	2	3	4	5	6	7	8	9	10
Quartz	54.1	16.6	38.6	58.2	73.8	34.6	42.4	72.0	–	–
Potassic Feldspar	–	0.6	6.0	8.4	14.4	–	–	2.1	–	–
Plagioclase	0.4	2.0	1.4	1.4	2.0	–	0.2	0.6	–	–
Lithic Fragments	6.3	21.8	–	9.8	0.8	1.4	–	–	–	–
Matrix	30.1	54.8	3.8	22.0	8.2	17.7	9.5	25.1	95.2	98.7
Muscovite	2.2	–	20.6	–	1.2	24.4	33.3	–	–	–
Biotite	6.3	–	19.0	0.2	x	–	–	–	–	–
Chlorite	–	3.4	9.2	–	0.6	21.1	13.2	–	–	–
Opaque Minerals	0.6	0.8	1.4	x	x	0.8	1.4	0.2	4.8	1.3
Zircon	–	–	–	x	–	–	–	–	–	–
An composition	An_{38-48}	An_{30-54}	An_{25-31}	An_{40-45}	An_{40}	An_{38}	An_{28-40}	An_{36-58}	nd	nd

1. 86RLD-1402 Lithic subarkosic wacke (Ramsay Lake)
2. 86RLD-2001 Lithwacke (Ramsay Lake)
3. 86RLD-5602 Metasediment (Ramsay Lake)
4. 86RLD-5702 Lithic subarkosic wacke (Ramsay Lake)
5. 86RLD-5703 Subarkose (Ramsay Lake)
6. 86RLD-1404 Lithwacke (Pecors)
7. 86RLD-1503 Metasediment (Pecors)
8. 86RLD-1605 Quartz wacke (Pecors)
9. 86RLD-2306 Siltstone (Pecors)
10. 86RLD-2602 Siltstone (Pecors)

–: not detected nd: not determined x: trace amounts present

	11	12	13	14	15	16	17	18	19	20
Quartz	29.2	21.6	65.2	–	–	73.8	75.0	74.4	–	33.6
Potassic Feldspar	–	–	19.8		–	4.8	14.8	16.6	–	3.0
Plagioclase	–	–	3.8	–	–	x	2.2	0.4	–	1.4
Lithic Fragments	–	–	–	–	–	5.4	0.4	–	8.9	–
Matrix	60.0	53.0	9.6	95.6	96.2	13.6	7.6	8.6	91.1	60.6
Muscovite	–	–	–	–	–	1.4	–	–	–	–
Biotite	–	0.4	–	x	x	x	–	–	–	–
Chlorite	–	16.6	1.4	x	1.8	0.8	–	–	–	–
Opaque Minerals	0.2	8.0	–	4.4	2.0	0.2	–	–	–	0.4
Scapolite	10.6	–	–	–	–	–	–	–	–	–
Calcite	–	–	0.2	x	–	–	–	–	–	–
Zircon	–	0.4	x	–	x	x	–	–	–	–
Titanite	–	–	–	–	–	–	–	–	–	1.0
An composition	nd	nd	An_{31-49}	nd	nd	An_{25-59}	An_{37-59}	An_{30-42}	nd	An_{42-49}

11. 86RLD-2604 Metasediment (Pecors)
12. 86RLD-3703 Lithwacke (Pecors)
13. 86RLD-5001 Arkose (Pecors)
14. 86RLD-5003 Siltstone (Pecors)
15. 86RLD-5102 Siltstone (Pecors)
16. 86RLD-5204 Sublitharenite (Pecors)
17. 86RLD-0402 Subarkose (Mississagi)
18. 86RLD-0502 Subarkose (Mississagi)
19. 86RLD-0604 Sudbury breccia (Mississagi)
20. 86RLD-0703 Subarkosic wacke (Mississagi)

–: not detected nd: not determined x: trace amounts present

	21	22	23	24	25	26	27	28	29	30
Quartz	48.4	65.0	41.0	50.0	49.6	70.6	73.2	37.0	47.8	35.6
Potassic Feldspar	28.8	12.4	8.8	2.2	8.0	3.0	8.4	2.4	2.2	2.0
Plagioclase	2.2	7.2	2.0	4.0	3.4	1.6	0.4	0.6	1.4	x
Lithic Fragments	–	–	–	–	1.6	0.6	0.8	3.6	37.8	–
Matrix	13.2	14.2	48.0	43.8	37.2	11.8	8.8	56.2	10.6	60.2
Muscovite	1.0	0.6	–	–	–	11.6	–	–	–	–
Biotite	–	0.6	–	–	–	–	6.0	x	0.2	0.4
Chlorite	–	–	–	–	–	–	0.4	–	–	1.2
Opaque Minerals	6.0	–	–	–	0.2	0.4	1.8	0.2	x	0.6
Calcite	–	–	–	–	–	0.4	–	–	–	–
Zircon	–	–	–	–	–	–	0.2	x	x	x
Titanite	0.2	–	0.2	x	–	–	–	–	–	–
Apatite	–	–	–	–	–	–	x	–	–	–
Rutile	0.2	–	–	–	–	–	–	–	–	–
An composition	An_{34-40}	An_{30-41}	An_{39-43}	An_{28-37}	An_{34-51}	An_{38-60}	An_{38-48}	An_{50-59}	An_{34-40}	An_{28-48}

21. 86RLD-0801 Arkose (Mississagi)
22. 86RLD-0805 Subarkose (Mississagi)
23. 86RLD-0902 Subarkosic wacke (Mississagi)
24. 86RLD-0905 Subarkosic wacke (Mississagi)
25. 86RLD-1302 Subarkosic wacke (Mississagi)
26. 86RLD-2003 Sublitharenite (Mississagi)
27. 86RLD-3704 Subarkose (Mississagi)
28. 86RLD-4102 Subarkosic wacke (Sandstone dike)
29. 86RLD-4204 Litharenite (Mississagi)
30. 86RLD-5402 Subarkosic wacke (Mississagi)

–: not detected nd: not determined x: trace amounts present

TABLE 5. WHOLE ROCK GEOCHEMICAL ANALYSES, HOUGH LAKE GROUP: RAMSAY LAKE, PECORS AND MISSISSAGI FORMATIONS.

	Major Components in Weight Percent								
	a	b	c	d	e	f	g	h	i
SiO_2	76.5	89.5	60.8	65.9	84.7	78.0	85.3	87.2	59.3
Al_2O_3	11.1	4.93	18.5	15.9	7.41	10.2	7.77	6.40	21.7
Fe_2O_3	0.54	0.18	1.22	1.01	0.44	2.39	0.31	0.61	2.10
FeO	3.18	0.95	4.74	4.77	0.74	0.70	0.59	0.44	1.41
MgO	1.49	0.88	2.78	2.82	1.04	0.96	0.57	0.56	2.30
CaO	1.74	0.13	1.10	1.09	0.11	0.13	0.13	0.16	0.38
Na_2O	1.82	1.15	1.07	2.43	2.20	3.42	2.49	1.24	0.87
K_2O	1.14	0.49	4.17	2.47	0.64	1.54	0.96	1.88	7.56
TiO_2	0.44	0.18	0.92	0.62	0.26	0.26	0.15	0.18	0.77
P_2O_5	0.06	0.04	0.09	0.10	0.03	0.00	0.01	0.02	0.08
MnO	0.05	0.01	0.03	0.06	0.00	0.00	0.00	0.00	0.01
CO_2	0.16	0.21	0.15	0.18	0.10	0.31	0.17	0.10	0.25
S	0.02	0.05	0.47	0.07	0.10	0.01	0.10	0.10	0.02
H_2O^+	1.11	0.62	2.39	2.19	0.69	0.94	0.26	0.29	1.64
H_2O^-	0.22	nd	0.09	0.08	nd	0.15	nd	0.05	0.09
Total	99.6	99.3	98.5	99.7	98.5	99.0	98.8	99.2	98.5
S.G.	nd	nd	2.79	nd	2.65	2.58	2.64	2.63	2.73

a. 86RLD-5702 Conglomerate (Ramsay Lake)
b. 86RLD-5703 Conglomerate (Ramsay Lake)
c. 86RLD-3703 Siltstone (Pecors)
d. 86RLD-5102 Siltstone (Pecors)
e. 86RLD-0402 Subarkose (Mississagi)
nd: not determined

f. 86RLD-0801 Arkose (Mississagi)
g. 86RLD-0805 Subarkose (Mississagi)
h. 86RLD-0905 Subarkosic wacke (Mississagi)
i. 86RLD-3902 Siltstone (Mississagi)

TABLE 6. MODAL ANALYSES, QUIRKE LAKE GROUP: BRUCE, ESPANOLA AND SERPENT FORMATIONS.

	1	2	3	4	5	6	7	8	9	10
Quartz	39.4	79.8	65.4	65.6	63.6	13.4	53.6	31.4	37.6	18.2
Potassic Feldspar	5.0	5.2	20.8	10.0	5.6	2.0	6.6	24.6	2.4	3.8
Plagioclase	0.2	4.4	2.8	1.6	0.6	0.4	6.6	2.0	0.4	1.2
Lithic Fragments	0.8	–	0.4	9.0	–	28.0	23.4	0.2	2.6	8.4
Matrix	54.0	7.0	2.8	13.2	2.2	56.2	1.4	22.8	53.2	66.0
Muscovite	–	3.4	0.4	0.4	4.2	–	–	–	–	–
Biotite	–	–	–	–	–	–	5.2	6.2	2.8	2.2
Chlorite	–	–	–	–	–	–	–	2.2	–	–
Opaque Minerals	0.6	0.2	0.4	0.2	–	x	0.2	0.8	1.0	0.2
Calcite	–	–	7.0	–	23.8	–	3.0	9.8	–	–
Zircon	–	–	–	–	–	–	–	–	x	x
Titanite	–	–	–	–	–	–	–	–	x	–
Apatite	–	–	–	x	–	–	–	–	x	–
Rutile	x	–	–	–	–	–	–	–	–	–
An composition	nd	An_{33-54}	An_{28-56}	An_{44-54}	An_{33-45}	An_{38-50}	An_{23-51}	An_{32-50}	An_{34-40}	An_{39-55}

1. 86RLD–0906 Subarkosic wacke (Bruce)
2. 86RLD–0907 Subarkose (Bruce)
3. 86RLD–1003 Arkose (Bruce)
4. 86RLD–1005 Subarkose (Bruce)
5. 86RLD–1006 Calcareous Subarkose (Bruce)
6. 86RLD–1104 Lithic wacke (Bruce)
7. 86RLD–2901 Feldspathic litharenite (Bruce)
8. 86RLD–3403 Lithic arkosic wacke (Bruce)
9. 86RLD–4207 Sublithwacke (Bruce)
10. 86RLD–4401 Feldspathic Lithwacke (Bruce)

–: *not detected* nd: *not determined* x: *trace amounts present*

	11	12	13	14	15	16	17	18	19	20
Quartz	54.2	33.8	–	1.6	9.8	24.6	–	–	3.8	15.4
Potassic Feldspar	23.6	2.6	0.4	–	–	–	–	–	–	0.6
Plagioclase	6.2	9.6	–	–	4.6	–	–	–	0.2	–
Lithic Fragments	–	–	–	29.0	–	–	–	–	x	0.2
Matrix	15.0	38.8	44.6	57.0	–	–	99.0	31.2	93.4	45.2
Phlogopite	–	–	–	–	–	6.7	–	–	–	–
Biotite	0.6	–	–	–	–	–	–	x	1.0	3.0
Chlorite	–	–	–	6.4	38.8	–	–	x	0.2	1.2
Opaques	0.2	0.2	x	1.4	–	–	1.0	0.4	1.0	0.4
Cordierite	–	–	–	–	–	–	–	–	–	34.0
Calcite/Dolomite	–	15.0	11.2	1.6	7.2	68.7	–	68.4	0.4	–
Amphibole	–	–	43.8	3.0	39.6	–	–	–	–	–
Zircon	–	–	–	–	–	–	–	x	x	x
Sphene	0.2	–	–	–	–	–	–	–	–	–
Apatite	–	–	x	–	–	–	–	–	–	–
An composition	An_{35-54}	An_{38-55}	nd	An_{45}	An_{51-60}	nd	nd	nd	nd	nd

11. 86RLD–1304 Arkosic wacke (Espanola)
12. 86RLD–1701 Calcareous arkosic wacke (Espanola)
13. 86RLD–1804 Skarn (Espanola)
14. 86RLD–1808 Skarn (Espanola)
15. 86RLD–1810 Skarn (Espanola)
16. 86RLD–2804 Siliceous limestone (Espanola)
17. 86RLD–2904 Siltstone (Espanola)
18. 86RLD–3406 Silty dolostone (Espanola)
19. 86RLD–4402 Siltstone (Espanola)
20. 86RLD–4403 Metasiltstone (Espanola)

–: *not detected* nd: *not determined* x: *trace amounts present*

	21	22	23	24	25	26	27
Quartz	–	37.6	42.8	37.4	54.6	31.6	–
Potassic Feldspar	–	28.6	38.4	37.8	24.0	36.4	–
Plagioclase	–	8.2	7.0	6.8	9.8	2.6	–
Lithic Fragments	–	0.4	3.4	3.6	7.6	–	–
Matrix	20.4	24.2	–	–	–	8.8	55.2
Muscovite	0.2	–	–	–	1.6	–	–
Biotite	–	–	4.2	10.4	–	14.8	–
Chlorite	1.8	x	3.6	0.8	0.4	0.2	42.2
Opaque Minerals	–	1.0	0.6	0.2	x	1.0	2.6
Calcite/Dolomite	77.6	–	–	3.0	2.0	–	–
Zircon	–	–	x	–	–	4.6	–
Titanite	–	–	–	–	–	x	–
Corundum	–	–	–	–	–	x	–
An composition	nd	An_{37-58}	An_{36-54}	An_{33-48}	An_{55-59}	An_{47-55}	nd

21. 86RLD–4605 Silty limestone (Espanola)
22. 86RLD–4608 Arkosic wacke (Espanola)
23. 86RLD–3001 Lithic arkose (Serpent)
24. 86RLD–3002 Lithic arkose (Serpent)
25. 86RLD–3006 Lithic arkose (Serpent)
26. 86RLD–3205 Lithic arkose (Serpent)
27. 86RLD–4902 Metasomatite (Serpent)

–: *not detected* nd: *not determined* x: *trace amounts present*

TABLE 7. WHOLE ROCK GEOCHEMICAL ANALYSES, QUIRKE LAKE GROUP: BRUCE, ESPANOLA AND SERPENT FORMATIONS.

	Major Components in Weight Percent					
	a	**b**	**c**	**d**	**e**	**f**
SiO_2	87.1	66.2	65.7	61.8	76.8	80.1
Al_2O_3	7.17	14.2	13.5	16.0	12.0	11.4
Fe_2O_3	0.15	1.69	0.54	1.74	0.43	0.20
FeO	0.30	3.81	2.70	3.55	0.79	0.40
MgO	0.16	3.48	3.61	4.46	1.46	0.28
CaO	0.11	1.82	3.40	0.50	0.64	0.34
Na_2O	2.59	3.84	4.19	5.90	3.45	4.06
K_2O	0.53	2.31	0.75	2.10	2.12	0.88
TiO_2	0.14	0.48	0.35	0.69	0.10	0.17
P_2O_5	0.02	0.14	0.12	0.14	0.05	0.06
MnO	0.00	0.05	0.03	0.02	0.02	0.01
CO_2	0.16	0.41	2.76	0.10	0.83	0.50
S	0.03	0.20	0.22	0.24	0.02	0.06
H_2O^+	0.14	1.06	1.44	1.16	0.43	0.20
H_2O^-	nd	nd	nd	0.07	nd	nd
Total	98.6	99.7	99.3	98.5	99.1	98.7
S.G.	2.63	nd	nd	2.68	nd	nd

a. 86RLD-0907 Subarkose (Bruce)
b. 86RLD-1104 Wacke (Bruce)
c. 86RLD-1701 Calcareous siltstone (Espanola)
nd: not determined

d. 86RLD-2904 Siltstone (Espanola)
e. 86RLD-3002 Arkose (Serpent)
f. 86RLD-3006 Arkose (Serpent)

TABLE 8. MODAL ANALYSES, COBALT GROUP: GOWGANDA AND LORRAIN FORMATIONS.

	1	2	3	4	5	6	7
Quartz	7.4	–	64.0	5.0	0.4	5.8	13.0
Potassic Feldspar	1.2	–	13.2	2.6	0.2	0.8	4.4
Plagioclase	0.4	–	3.6	–	–	–	0.6
Lithic Fragments	12.4	–	2.6	1.4	–	–	3.6
Matrix	72.4	98.8	15.0	89.6	99.4	92.8	77.2
Muscovite	0.4	–	–	0.2	–	–	–
Biotite	1.6	–	–	0.2	–	–	–
Chlorite	1.0	–	0.6	0.4	–	–	0.4
Opaque Minerals	2.8	–	1.0	0.4	–	0.6	0.6
Calcite	0.4	1.2	–	0.2	–	–	–
Monazite	–	–	–	–	–	–	0.2
An composition	An_{40}	nd	An_{35-57}	nd	nd	nd	An_{28-48}

1. 86RLD-3008 Lithwacke (Gowganda)
2. 86RLD-3101 Siltstone (Gowganda)
3. 86RLD-3102 Subarkosic wacke (Gowganda)
4. 86RLD-3103 Siltstone (Gowganda)
5. 86RLD-3201 Siltstone (Gowganda)
6. 86RLD-3202 Siltstone (Gowganda)
7. 86RLD-3203 Siltstone (Gowganda)
–: not detected
nd: not determined
x: trace amounts present

	8	9	10	11	12	13	14
Quartz	42.2	5.1	47.4	57.2	63.0	55.6	23.6
Potassic Feldspar	35.6	2.7	36.0	35.6	26.4	29.6	1.2
Plagioclase	4.0	1.1	3.6	2.4	3.8	2.8	–
Lithic Fragments	0.4	78.3	1.0	2.8	5.0	3.8	–
Matrix	11.2	9.7	2.0	0.6	1.2	8.2	75.0
Muscovite	–	–	1.2	x	0.6	x	–
Biotite	–	–	x	–	–	–	–
Chlorite	5.2	–	3.6	–	–	–	–
Opaque Minerals	1.4	0.8	3.0	1.4	x	–	0.2
Calcite	–	–	2.2	–	–	–	–
Amphibole	–	2.3	–	–	–	–	–
Zircon	x	x	x	–	–	–	–
Titanite	–	–	–	x	x	–	–
An composition	An_{37-55}	An_{38-44}	An_{33-63}	An_{38-45}	An_{29-56}	An_{40-52}	nd

8. 86RLD-4502 Arkose (Gowganda)
9. 86RLD-4504 Polymictic conglomerate (Gowganda)
10. 86RLD-4505 Arkose (Lorrain)
11. 86RLD-5801 Arkose (Lorrain)
12. 86RLD-5802 Arkose (Lorrain)
13. 86RLD-5804 Arkose (Lorrain)
14. 86RLD-5806 Sudbury breccia (Lorrain)
–: not detected
nd: not determined
x: trace amounts present

TABLE 9. WHOLE ROCK GEOCHEMICAL ANALYSES, COBALT GROUP: GOWGANDA AND LORRAIN FORMATIONS.

	Major Components in Weight Percent			
	a	b	c	d
SiO_2	64.5	77.7	85.8	77.9
Al_2O_3	15.3	11.7	8.40	12.4
Fe_2O_3	1.63	0.76	0.10	0.60
FeO	4.37	1.51	0.15	0.22
MgO	3.03	0.75	0.09	0.20
CaO	1.02	0.23	0.07	0.09
Na_2O	4.58	4.53	2.43	2.31
K_2O	2.05	0.24	2.65	4.63
TiO_2	0.51	0.21	0.07	0.09
P_2O_5	0.14	0.08	0.01	0.02
MnO	0.04	0.02	0.02	0.02
CO_2	0.34	0.41	0.14	0.09
S	0.12	0.02	0.01	0.01
H_2O^+	1.72	0.60	0.00	0.58
H_2O^-	0.07	0.08	nd	nd
Total	99.4	98.8	99.9	99.2
S.G.	nd	nd	2.62	2.64

a. 86RLD-3203 Siltstone (Gowganda)
b. 86RLD-4502 Arkose (Gowganda)
c. 86RLD-5802 Arkose (Lorrain)
d. 86RLD-5804 Arkose (Lorrain)
nd: not determined

TABLE 10. MODAL ANALYSES, NIPISSING INTRUSIVE ROCKS.

	1	2
Quartz	0.8	50.4
Potassic Feldspar	22.8	20.2
Micrographic Intergrowths	40.0	–
Plagioclase	26.4	28.6
Matrix	–	0.6
Muscovite	5.4	0.2
Chlorite	2.4	–
Opaque Minerals	x	–
Calcite	2.2	–
Titanite	–	x
An composition	An_{29-40}	An_{30-50}

1. 86RLD-4702 Granophyre
2. 86RLD-5201 Adamellite
–: not detected
x: trace amounts present

TABLE 11. WHOLE ROCK GEOCHEMICAL ANALYSES, NIPISSING INTRUSIVE ROCKS.

	Major Components in Weight Percent a
SiO_2	82.1
Al_2O_3	10.9
Fe_2O_3	0.00
FeO	0.16
MgO	0.07
CaO	0.43
Na_2O	4.27
K_2O	0.52
TiO_2	0.12
P_2O_5	0.02
MnO	0.01
CO_2	0.26
S	0.01
H_2O^+	0.29
H_2O^-	nd
Total	99.2
S.G.	nd

a. 86RLD-5201 Adamellite
nd: not determined

TABLE 12. SUMMARY OF GOLD GEOCHEMICAL ANALYSES, HURONIAN SUPERGROUP SEDIMENTS.

Formation	Number of Analyses	Low	Au-ppb Mean	High
Lorrain	1	< 2	< 2	< 2
Gowganda	2	< 2	9	15
Serpent	2	< 2	< 2	< 2
Espanola	2	< 2	2	< 2
Bruce	8	< 2	2	4
Mississagi	14	< 2	3	10
Pecors	8	< 2	3	7
Ramsay Lake	6	< 2	3	4
McKim	2	< 2	3	5
Matinenda	6	< 2	43	85
Stobie	1	< 2	< 2	< 2

TABLE 13. SUMMARY OF GOLD GEOCHEMICAL ANALYSES OF QUARTZ VEIN STOCKWORKS.

Formation	Number of Analyses	Low	Au-ppb Mean	High
Serpent	4	< 2	3	6
Bruce	1	3	3	3
Mississagi	4	< 2	102	400
McKim	1	< 2	< 2	< 2

TABLE 14. WHOLE ROCK GEOCHEMICAL ANALYSES, METASOMATICALLY ALTERED ROCKS.

	Major Components in Weight Percent		
	a	b	c
SiO_2	41.2	66.4	59.2
Al_2O_3	11.9	19.5	17.1
Fe_2O_3	0.44	0.56	1.55
FeO	2.67	0.15	5.33
MgO	6.25	0.26	3.89
CaO	11.6	0.28	0.60
Na_2O	6.38	10.1	6.72
K_2O	0.50	0.27	0.55
TiO_2	0.50	0.83	0.75
P_2O_5	0.10	0.12	0.12
MnO	0.08	0.02	0.02
CO_2	17.8	0.15	0.55
S	0.06	0.18	0.02
H_2O^+	0.21	0.21	2.47
H_2O^-	0.05	0.07	0.07
Total	99.7	98.9	98.9
S.G.	2.76	2.62	2.71

a. 86RLD-3408 Altered Espanola arkose
b. 86RLD-4608 Altered Espanola siltstone
c. 86RLD-4902 Altered Serpent arkose

TABLE 15. SUMMARY OF GOLD GEOCHEMICAL ANALYSES OF ALTERED AND METASOMATIZED ROCKS, AND QUARTZ AND QUARTZ–CARBONATE VEINS.

Lithology	Number of Analyses	Low	Au–ppb Mean	High
Altered Nipissing Gabbro	2	8	8	8
Metasomatized Gowganda Argillite	3	< 2	3	5
Metasomatized Espanola Siltstone and Arkose	5	< 2	360	1790
Quartz and Quartz–Carbonate Veins	7	< 2	1475	6350

TABLE 16. LIST OF SAMPLES BY FORMATION FOR SAMPLES HAVING MODAL ANALYSES, WITH POINT NUMBER ON TERNARY DIAGRAMS, SAMPLE NUMBER, MODAL ROCK NAME, MAP LEGEND AND FIELD ROCK NAME.

Elliot Lake Group				
Stobie Formation				
	86RLD-0203	Dacite	10e	Dacite
	86RLD-1901	Siltstone	10c	Siltstone
Copper Cliff Formation				
	86RLD-5301	Rhyolitic crystal lithic lapillistone	11b	Crystal lithic tuff
	86RLD-5302	Rhyolitic crystal tuff	11a	Crystal tuff
	86RLD-5305	Arkose to arkosic wacke	11d	Wacke
	86RLD-5306	Arkose to arkosic wacke	11d	Arkose
Matinenda Formation				
1.	86RLD-2305	Sublithwacke	12a	Quartzofeldspathic arenite
2.	86RLD-2312	Sublithwacke	12b	Quartzofeldspathic arenite
3.	86RLD-2313	Sublithwacke	12b	Wacke
McKim Formation				
4.	86RLD-5307	Feldspathic lithwacke	13a	Feldspathic arenite
5.	86RLD-5501	Lithic subarkosic wacke	13a	Quartzose wacke
6.	86RLD-5502	Sublithwacke	13a	Quartzose wacke
7.	86RLD-5601	Metasediment	13a	Wacke
8.	86RLD-6002	Sublithwacke	13a	Quartzose wacke
Hough Lake Group				
Ramsay Lake Formation				
1.	86RLD-1402	Lithic subarkosic wacke	14a	Pebbly wacke
2.	86RLD-2001	Lithwacke	14c	Lithic wacke
3.	86RLD-5602	Metasediment	14a	Conglomerate
4.	86RLD-5702	Lithic subarkosic wacke	14c	Quartzose wacke
5.	86RLD-5703	Subarkose	14b	Quartzose arenite
Pecors Formation				
6.	86RLD-1404	Sublithwacke	15a	Quartzose wacke
7.	86RLD-1503	Metasediment	15a	Wacke
8.	86RLD-1605	Quartz wacke	15b	Lithic wacke
9.	86RLD-2306	Siltstone	15a	Siltstone
10.	86RLD-2602	Siltstone	15a	Siltstone
11.	86RLD-2604	Metasediment	15a	Siltstone
12.	86RLD-3703	Lithwacke	15a	Siltstone
13.	86RLD-5001	Arkose	15b	Quartzose arenite
14.	86RLD-5003	Siltstone	15a	Siltstone
15.	86RLD-5102	Siltstone	15a	Siltstone
16.	86RLD-5204	Sublitharenite	15b	Quartzose arenite
Mississagi Formation				
17.	86RLD-0402	Subarkose	16a	Quartzose arenite
18.	86RLD-0502	Subarkose	16a	Quartzose arenite
19.	86RLD-0604	Sudbury breccia	16	Sudbury breccia
20.	86RLD-0703	Subarkosic wacke	16b	Feldspathic wacke
21.	86RLD-0801	Arkose	16a	Feldspathic arenite
22.	86RLD-0805	Subarkose	16a	Quartzose arenite
23.	86RLD-0902	Subarkosic wacke	16b	Quartzose wacke
24.	86RLD-0905	Subarkosic wacke	16a	Feldspathic arenite
25.	86RLD-1302	Subarkosic wacke	16b	Quartzose wacke
26.	86RLD-2003	Sublitharenite	16b	Quartzose wacke
27.	86RLD-3704	Subarkose	16a	Subarkose
28.	86RLD-4102	Subarkosic wacke (Sandstone dike)	16	Quartzose wacke
29.	86RLD-4204	Litharenite	16b	Pebbly quartzose arenite
30.	86RLD-5402	Subarkosic wacke	16b	Wacke

TABLE 16. (Continued)

Quirke Lake Group				
Bruce Formation				
1.	86RLD-0906	Subarkosic wacke	17b	Quartzose wacke
2.	86RLD-0907	Subarkose	17c	Arkose
3.	86RLD-1003	Arkose	17c	Arkose
4.	86RLD-1005	Subarkose	17c	Quartzose arenite
5.	86RLD-1006	Calcareous Subarkose	17c	Quartzose arenite
6.	86RLD-1104	Lithic wacke	17a	Pebbly wacke
7.	86RLD-2901	Feldspathic litharenite	17a	Feldspathic arenite
8.	86RLD-3403	Lithic arkosic wacke	17c	Feldspathic wacke
9.	86RLD-4207	Sublithwacke	17a	Quartzose wacke
10.	86RLD-4401	Feldspathic lithwacke	17a	Wacke
Espanola Formation				
11.	86RLD-1304	Arkosic wacke	18	Arkose
12.	86RLD-1701	Calcareous arkosic wacke	18	Siltstone
13.	86RLD-1804	Skarn	18	Silty limestone
14.	86RLD-1808	Skarn	18	Skarn
15.	86RLD-1810	Skarn	18	Skarn
16.	86RLD-2804	Siliceous limestone	18	Calcareous quartz arenite
17.	86RLD-2904	Siltstone	18	Siltstone
18.	86RLD-3406	Silty dolostone	18	Siltstone
19.	86RLD-4402	Siltstone	18	Siltstone
20.	86RLD-4403	Metasiltstone	18	Siltstone
21.	86RLD-4605	Silty limestone	18	Silty limestone
22.	86RLD-4608	Arkosic wacke	18	Siltstone
Serpent Formation				
23.	86RLD-3001	Lithic arkose	19a	Arkose
24.	86RLD-3002	Lithic arkose	19a	Arkose
25.	86RLD-3006	Lithic arkose	19a	Arkose
26.	86RLD-3205	Lithic arkose	19a	Arkose
27.	86RLD-4902	Metasomatite	19	Chloritized arkose
Cobalt Group				
Gowganda Formation				
1.	86RLD-3008	Lithwacke	20b	Siltstone
2.	86RLD-3101	Siltstone	20b	Siltstone
3.	86RLD-3102	Subarkosic wacke	20c	Arkose
4.	86RLD-3103	Siltstone	20a	Siltstone
5.	86RLD-3201	Siltstone	20b	Cherty siltstone
6.	86RLD-3202	Siltstone	20	Metasomatized siltstone
7.	86RLD-3203	Siltstone	20a	Siltstone
8.	86RLD-4502	Arkose	20c	Arkose
9.	86RLD-4504	Polymictic conglomerate	20d	Polymictic paraconglomerate
Lorrain Formation				
10.	86RLD-4505	Arkose	21b	Feldspathic arenite
11.	86RLD-5801	Arkose	21a	Arkose
12.	86RLD-5802	Arkose	21a	Arkose
13.	86RLD-5804	Arkose	21a	Arkose
14.	86RLD-5806	Sudbury breccia	21	Sudbury breccia
Nipissing Intrusive Rocks				
	86RLD-4702	Granophyre	23b	Granophyre
	86RLD-5201	Adamellite	23c	Granite

TABLE 17. LIST OF SAMPLES BY FORMATION FOR SAMPLES HAVING WHOLE ROCK GEOCHEMICAL ANALYSES.

Elliot Lake Group		
Stobie Formation		
	86RLD-0203	Dacite
	86RLD-1902	Basalt
Copper Cliff Formation		
	86RLD-5302	Rhyolitic crystal tuff
McKim Formation		
	86RLD-5501	Wacke
Hough Lake Group		
Ramsay Lake Formation		
	86RLD-5702	Conglomerate
	86RLD-5703	Conglomerate
Pecors Formation		
	86RLD-3703	Siltstone
	86RLD-5102	Siltstone
Mississagi Formation		
	86RLD-0402	Subarkose
	86RLD-0801	Arkose
	86RLD-0805	Subarkose
	86RLD-0905	Subarkosic wacke
	86RLD-3902	Siltstone
Quirke Lake Group		
Bruce Formation		
	86RLD-0907	Subarkose
	86RLD-1104	Wacke
Espanola Formation		
	86RLD-1701	Calcareous siltstone
	86RLD-2904	Siltstone
Serpent Formation		
	86RLD-3002	Arkose
	86RLD-3006	Arkose
Cobalt Group		
Gowganda Formation		
	86RLD-3203	Siltstone
	86RLD-4502	Arkose
Lorrain Formation		
	86RLD-5802	Arkose
	86RLD-5804	Arkose
Metasomatically Altered Rocks		
	86RLD-3408	Altered Espanola siltstone
	86RLD-4608	Altered Espanola siltstone
	86RLD-4902	Altered Serpent arkose
Nipissing Intrusive Rocks		
	86RLD-5201	Adamellite

TABLE 18. LIST OF TRACE ELEMENT GEOCHEMICAL ANALYSES BY FORMATION.

		Au (ppb)	Ag (ppm)	As (ppm)	Cu (ppm)
Elliot Lake Group					
Stobie Formation					
86RLD-1901	Wacke	< 2	< 2		
86RLD-1902	Basalt	< 2	< 2		
86RLD-2702	Basalt	350	< 2		
Matinenda Formation					
86RLD-2302	Wacke	9	< 2		
86RLD-2303	Conglomerate	85	< 2		
86RLD-2305	Wacke	75	< 2		
86RLD-2312	Wacke	80	< 2		
86RLD-2313	Wacke	< 2	< 2		75
86RLD-2601	Wacke	< 2	< 2		
McKim Formation					
86RLD-5503	Wacke	< 2	< 2		
86RLD-5601	Wacke	5	< 2		
Hough Lake Group					
Ramsay Lake Formation					
86RLD-1401	Wacke	4	< 2		
86RLD-1402	Wacke	< 2	< 2		
86RLD-1602	Wacke	3	< 2		
86RLD-2001	Wacke	2	< 2		
86RLD-5602	Wacke	< 2	< 2		
Pecors Formation					
86RLD-1503	Wacke	2	< 2		
86RLD-1504	Conglomerate	< 2	< 2		
86RLD-1604	Subarkose	< 2	< 2		
86RLD-1605	Wacke	5	< 2		
86RLD-2306	Siltstone	< 2	< 2		
86RLD-2602	Siltstone	< 2	< 2		
86RLD-3703	Wacke	< 2	< 2	1.5	
86RLD-5204	Quartz arenite	< 2	< 2		
86RLD-5704	Wacke	7	< 2		99
Mississagi Formation					
86RLD-0101	Subarkose	< 2	4		
86RLD-0301	Quartz arenite	< 2	< 2		
86RLD-0904	Wacke	< 2	< 2		
86RLD-1301	Subarkose	10	< 2		
86RLD-1405	Subarkose	< 2	< 2		
86RLD-1502	Quartz arenite	< 2	< 2		
86RLD-2205	Wacke	< 2	< 2		
86RLD-2307	Subarkose	< 2	< 2		
86RLD-3903	Subarkose	< 2	< 2		
86RLD-4201	Subarkose	< 2	< 2		
86RLD-4203	Wacke	3	< 2		
86RLD-4204	Lithic arkose	< 2	< 2		
86RLD-4205	Quartz arenite	5	< 2		12
86RLD-4206	Wacke	< 2	< 2		
86RLD-4207	Quartz wacke	< 2	< 2		
86RLD-5402	Wacke	2	< 2		
86RLD-5403	Subarkose	< 2	< 2		
Quirke Lake Group					
Bruce Formation					
86RLD-0906	Wacke	< 2	< 2		
86RLD-1004	Siltstone	4	< 2		
86RLD-1303	Arkosic wacke	3	< 2		
86RLD-3402	Wacke	< 2	< 2		
86RLD-3403	Wacke	2	< 2		
86RLD-4207	Quartz wacke	< 2	< 2		
86RLD-4401	Conglomerate	< 2	< 2		
86RLD-4803	Wacke	< 2	< 2		
Espanola Formation					
86RLD-2804	Arkose	< 2	< 2		
86RLD-2904	Siltstone	< 2	< 2	9	
86RLD-4402	Wacke	< 2	< 2		

TABLE 18. (Continued)

		Au (ppb)	Ag (ppm)	As (ppm)	Cu (ppm)
Serpent Formation					
86RLD-3004	Arkose	< 2	< 2		
86RLD-3206	Arkose	< 2	< 2		
86RLD-3502	Arkose	< 2	< 2		
Cobalt Group					
Gowganda Formation					
86RLD-3101	Siltstone	< 2	< 2		
86RLD-3102	Arkose	< 2	< 2		
86RLD-3103	Siltstone	5	< 2		
86RLD-3202	Siltstone	< 2	< 2		
86RLD-4503	Arkose	15	< 2		
Lorrain Formation					
86RLD-4505	Arkose	< 2	< 2		
86RLD-5802	Arkose	7	< 2	< 1	
86RLD-5804	Arkose	< 2	< 2	< 1	
Nipissing Intrusive Rocks					
86RLD-4602	Carbonate alteration	8	< 2		
86RLD-4704	Propylitic alteration	8	< 2		
Quartz Vein Stockworks					
86RLD-0401	Mississagi Formation	< 2	< 2		
86RLD-0701	Mississagi Formation	400	< 2		
86RLD-1802	Serpent Formation	2	< 2		
86RLD-2308	Mississagi Formation	< 2	< 2		
86RLD-3005	Serpent Formation	6	< 2		
86RLD-3503	Serpent Formation	< 2	< 2		
86RLD-5309	McKim Formation	< 2	< 2		
Quartz and Quartz-Carbonate Veins					
86RLD-2309	Quartz-carbonate vein	40	< 2		
86RLD-3404	Quartz-carbonate vein	7	< 2		
86RLD-3405	Quartz-carbonate vein	< 2	< 2		
86RLD-3407	Quartz-carbonate vein	13	< 2		
86RLD-3409	Quartz-carbonate vein	< 2	< 2		
86RLD-4601	Quartz vein	470	< 2		
86RLD-4604	Quartz vein	6350	2		
86RLD-4703	Quartz-carbonate vein	490	< 2		17
Metasomatic Alteration and Skarns					
86RLD-1201	Metasomatite (Bruce)	< 2	< 2		
86RLD-1810	Skarn (Espanola)	10	< 2		
86RLD-2905	Metasomatite (Espanola)	3	< 2		
86RLD-3406	Metasomatite (Espanola)	< 2	< 2		
86RLD-3408	Metasomatite (Espanola)	13	< 2	10	
86RLD-3410	Metasomatite (Espanola)	1790	< 2	200	
86RLD-4607	Metasomatite (Espanola)	< 2	< 2		
86RLD-4608	Metasomatite (Espanola)	8	< 2	24	
86RLD-4902	Metasomatite (Serpent)	4	< 2	13	

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